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Mariners Weather Log

- **Malstrøm — fact or fiction? — page 10**
- **Abbie saves the chickens — page 18**
- **A new club — the SATCATS — page 21**

Government Lighthouse
Port Sanilac, Michigan
by Leo Kuschel

Built in 1886, the Government Lighthouse stands 69 feet above Lake Huron. The lighthouse is in the heart of the village of Port Sanilac. The port is an artificial harbor, used by pleasure craft. It is about 30 miles north of the head of the St. Clair River on the west shore of Lake Huron. Sketches published by:

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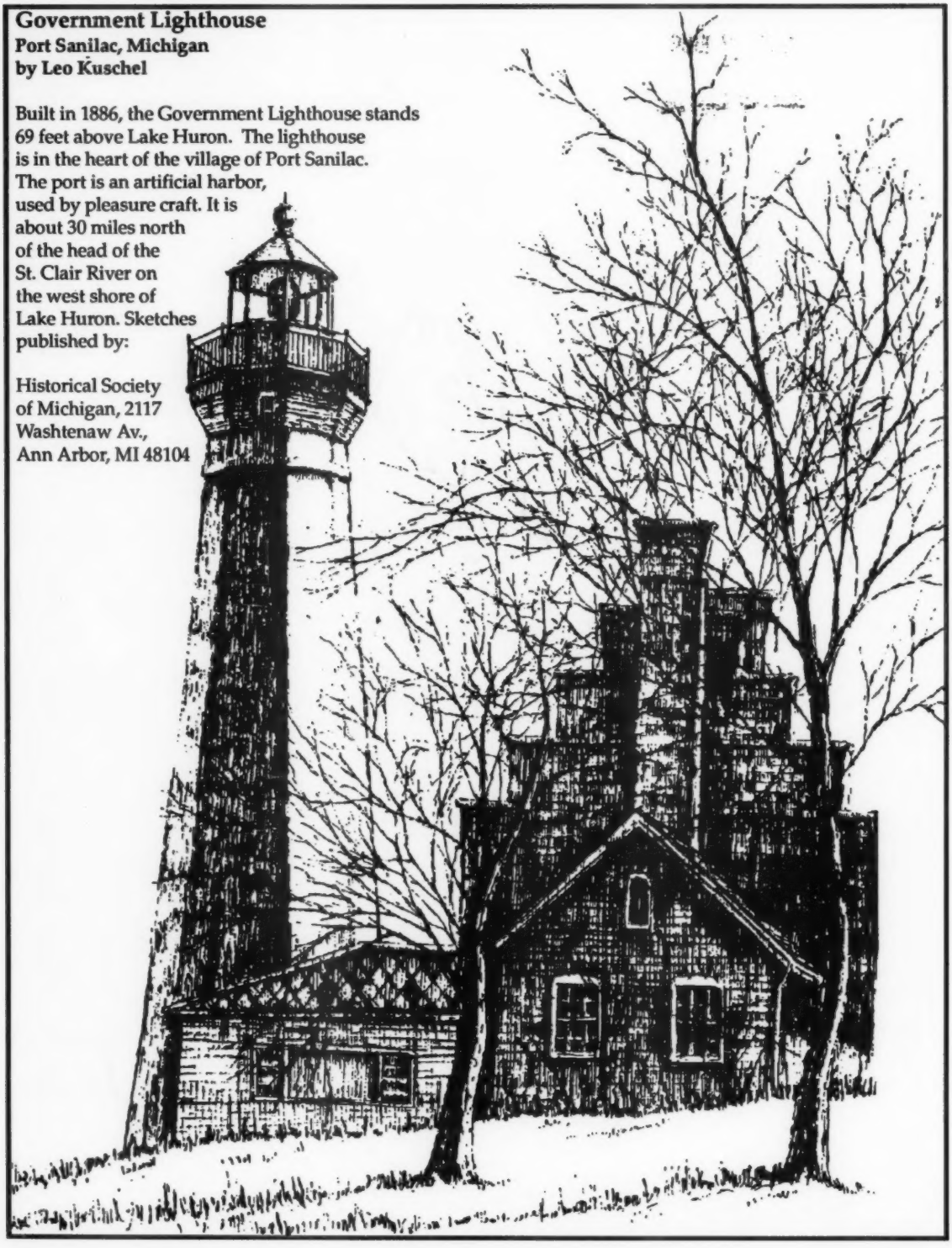

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Documents Department

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Vol. 33, No. 1

January, February, March 1989

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Cover: The Malstrøm, described in Edgar Allan Poe's, *A Descent into the Maelstrøm*, was illustrated in pen and ink by Arthur Rackham. The sketch appears in ***Tales of Terror and Fantasy*** by E.P Dutton & Co. The story also appears in ***Tales and Poems of Edgar Allan Poe*** by Macmillan Publishing Co.

Back Cover: The Matinicus Rock Light Station, Maine was the home of Abbie Burgess; her story is on page 18. This photo from the National Archives is circa 1890.

Editor: Richard M. DeAngelis

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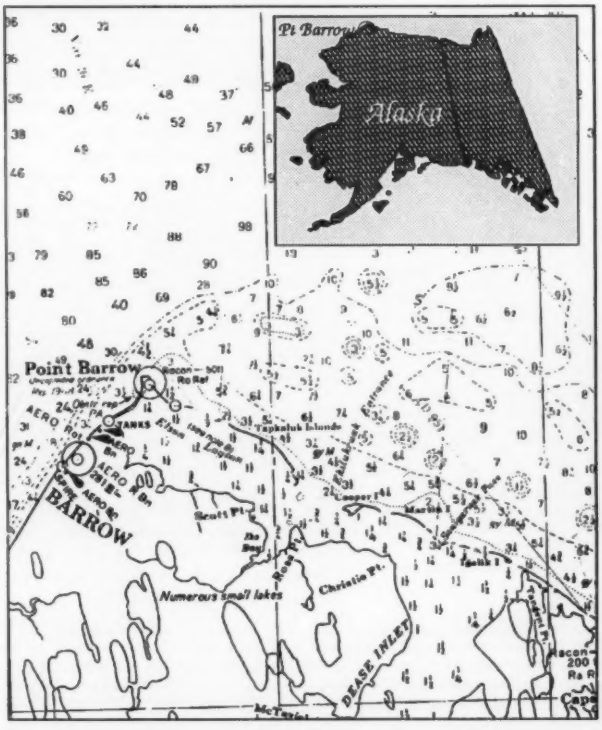
Whale Diary

The whales shown left and below right were photographed when all three were still alive and using the breathing holes, which were enlarged by Eskimos with chain saws on the 15th of October. They were able to remove an estimated 600 tons of ice. The NOS chart below shows the area where the whales were trapped, some 12 miles to the east of Barrow, AK.



For almost three weeks last October the attention of most of the United States, and, indeed, much of the world, was riveted on three California gray whales trapped in the ice off Point Barrow, on the North Slope of Alaska. Their plight, their strong will to live, and the remarkable cooperation of state and federal agencies, environmental groups and Alaska natives, oil companies, ordinary citizens and the Soviet Union is summarized in this report from NOAA's Alaska Regional Fisheries office in Juneau.

Thursday, October 13— In Alaska, the Anchorage Daily News carries a front-page story by the Associated Press about three gray whales trapped in 6-inch-thick ice 450 feet from shore and about 12 miles east of Barrow. The whales are using two breathing holes "about the size of basketball courts," but the story leaves the impression that saving the whales is not likely.

Ron Morris, with the NOAA Fisheries field office in Anchorage, and Dr. Steven Zimmerman, Chief of the Fisheries Office of Marine Mammals and Endangered Species in Juneau, consult with their colleagues at the North Slope Borough Department of Wildlife Management. They learn the whales had been first

discovered a week earlier by a hunter. Because open water is reported to be some 2 miles away and because near-record temperatures are rapidly closing the breathing holes, little hope is held for the whales.

Friday, October 14— Morris learns that the nearest open water is not 2 miles away as originally reported, but 4 to 5 miles away. The two breathing holes have begun to close overnight and are now about 15 by 30 feet each. Hope fades even more for the whales.

Saturday, October 15— The whales are receiving increasing media coverage. Greenpeace and NOAA Fisheries look into getting a hovercraft barge, owned by VECO, an oil field supply company. The barge, almost 200 miles away and unused for four years, might be able to break the ice and cut a channel for the whales.

The Defense Department approves the barge plan and authorizes money for the Alaska National Guard to use two Sikorski CH-54 Skycrane helicopters to ferry the barge to Barrow.

Conditions are deteriorating rapidly for the whales. Their breathing holes have been reduced by one-third and the nearest open water is now 4.7 miles away. Exacerbating matters is a 30-foot-high pressure ridge of ice at the edge of the ice sheet, a wall certainly impregnable to the hovercraft, should it arrive.

The whales appear exhausted and badly cut with one whale's nose so damaged and bloody the underlying bone is exposed.

In an attempt to buy time for the whales, Morris and a group of Barrow Eskimos use chain saws to enlarge the breathing holes during the afternoon and evening. Experts later estimate the volunteers moved about 600 tons of ice.

James Brennan, head of NOAA Fisheries, designates Morris as NOAA's on-scene coordinator.

Sunday, October 16— The two breathing holes are now only 10 feet by 20, making it impossible for the whales to breathe normally. But chain saw crews are trying valiantly to enlarge the holes. The whales look terrible and have to swim constantly because of a swift current.

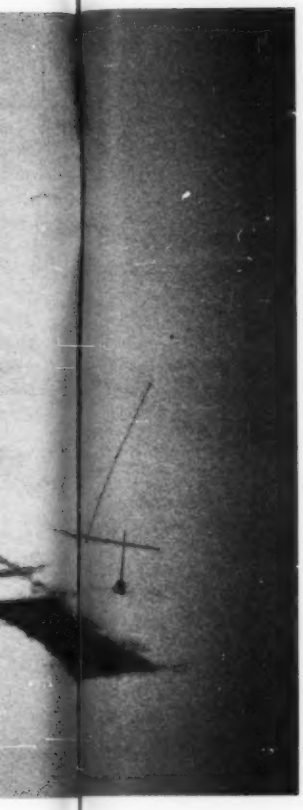
NBC already has a film crew in Barrow and others are on the way. Worldwide media interest continues to increase.

Monday, October 17— The pace of telephone calls— from reporters, concerned citizens, technicians— grows. For the next week NOAA'S Ted Meyers and John Sease will devote virtually all their time to answering several hundred calls from the U.S., Canada, Australia, New Zealand, Great Britain, Sweden and Switzerland.

Crews with VECO, the oil field supply company, work around the clock to prepare their hovercraft. As temperatures hover around –20° F at night, Inupiat Eskimos and other volunteers work frantically to keep the whales' breathing holes open.

One of the whales, the smallest and most badly injured, is wheezing noticeably and on-site veterinarians speculate it may have pneumonia.

Tuesday, October 18— President Reagan calls the National Guard in



Volunteers cut a path toward the open water (left) and the whales begin to follow. One of the many problems encountered occurred after a series of 55 holes had been opened and the whales refused to cross a 12–foot deep shallow area. By night on the 21st it was noticed that the smaller whale was no longer surfacing. After a search it was determined that he had died. Additional help was coming from the Navy/NOAA Joint Ice Center, Soviet icebreakers and VECO, which was sending an Archimedean Screw Tractor to assist in cutting a swath through the ice.

Prudhoe Bay and offers encouragement to everyone involved in the rescue effort.

Wednesday, October 19— The hover barge continues to be plagued with problems and makes minuscule progress. In Barrow, workers on the ice begin to cut new holes hoping to move the whales toward open water, still almost five miles away. Omark Industries of Oregon donates a supply of special saw chain and provides two technicians to sharpen dull chains.

Drifting snow has filled the breathing holes, turning the openings into slush that threatens to freeze and close the holes entirely. By late afternoon, however, Greg Ferrian and Rick Skluzacek, volunteers from Lakeland, Min., arrive with six water circulation pumps used to prevent ice from forming at boat moorings. The pumps help keep the holes open that night and during the days to follow.

Thursday, October 20— One of the breathing holes has been greatly enlarged, allowing the whales to come to the surface and breathe close to normally for the first time in 2 weeks. Biologists also get their first chance to estimate the length of the whales: 25, 27, 35 feet.

National Weather Service ice expert Dr. Gary Hufford arrives at Barrow to assist in the rescue operation.

The chain saw crew, discouraged by the slow progress of the hover barge, begins to cut a series of holes toward open water, now about 4.3 miles away.

The whales themselves appear to be in better shape and are breathing more normally. They are responding positively to the water pumps in the leading hole, giving biologists hope that the whales can be lured out to open water.

Friday, October 21— Hope is all but abandoned for the hovercraft. It has progressed only 6 miles in 2 days. One of the Skycrane helicopters is sent to Barrow with a 9,000-pound concrete cylinder to punch holes in the ice.

The chain saw crews increase their pace, working around the clock, cutting a trail of holes toward the open lead.

The 30-foot-high pressure ridge at the edge of the ice still looms 3 to 4 miles away, however, and no one seems to know how it can be breached.

Two whale biologists, David Withrow and James Harvey, arrive at Barrow from NOAA's National Marine Mammal Laboratory in Seattle.

Under Secretary WilliamEvans, having worked through the week to locate an icebreaker, is informed that two Soviet icebreakers are in the vicinity. With State Department help, Evans requests the Soviets' assistance. Within 90 minutes the Soviets volunteer their craft: the 443-foot ***Admiral Makarov*** and the 413-foot ***Vladimir Arseniev***.

Shortly before dark, workers notice that the smallest whale is no longer surfacing. An immediate search of the entire series of holes fails to locate the whale, and it is presumed dead.

Saturday, October 22— The rescue team begins to focus on methods to get the two remaining whales past the seemingly impenetrable pressure ridge, including considering using explosives to clear a path or constructing a sling to airlift the whales over the ice to open water.

The whales have encountered another barrier: although a string of 55 holes has been opened, the whales refuse to cross a shallow area only 12 feet deep.

Rear Admiral Sigmund Petersen, Pacific Commander for NOAA, and his aide LCDR Terry Jackson, arrive in Barrow to coordinate logistics for the rescue.

The Air Force, using an enormous C-5A cargo plane, sends VECO's Archimedean Screw Tractor to the site. The equipment is capable of cutting a 15-foot-wide swath through the ice using its corkscrew-like pontoons.

Sunday, October 23— In Suitland, MD, Glenn Rutledge of NOS working with his colleagues at the Navy/NOAA Joint Ice Center, begins producing vital data and special daily ice analyses showing ice thickness and openings using NESDIS satellite imagery. The information is transmitted to Barrow where it is relayed by radio to the Soviet icebreakers for the next several days.

Monday, October 24— Attention is concentrated on the Soviet icebreakers, scheduled to arrive this afternoon.

Although the NOAA-11 satellite, launched a month before, isn't scheduled for operation until December, NESDIS head Tom Pyke orders the satellite turned on and it immediately begins producing imagery to augment ice analysis.

Tuesday, October 25— Petersen, Morris, Coast Guard Captain James McCelland and NOAA Corps interpreter Lt. Svetlana Andreeva helicopter to the Admiral Makarov at noon to turn over satellite image analyses, charts and other data. By mid-afternoon the Soviet ships begin attacking the pressure ridge, breaking open a quarter-mile section almost immediately. Meanwhile, the ice crew has cut a new series of holes for the whales, bypassing the shallow area.

By nightfall, the ***Arseniev*** has cut a channel to within a quarter mile of the whales.

Wednesday, October 26— Crowd control becomes a problem, as hundreds

One of the major obstacles in this project was the 30–foot high pressure ridge at the edge of the ice. This was finally solved by the arrival of the two Soviet icebreakers (left), which broke open a quarter–mile section. The shallow water problem was solved by cutting a new series of holes. By nightfall on the 25th the ***Arseniev*** *had cut a channel to within a quarter mile of the whales. On the other end the Archimedean Screw Tractor (above) is flown in by the U.S. Air Force aboard a C–5A.*

of reporters, Barrow residents, technicians and others observe the progress of the two Soviet ships. The ***Arseniev*** comes within 400 yards of the whales and as darkness approaches, the whales follow the icebreakers out into open water, raising hopes that they may swim free this evening.

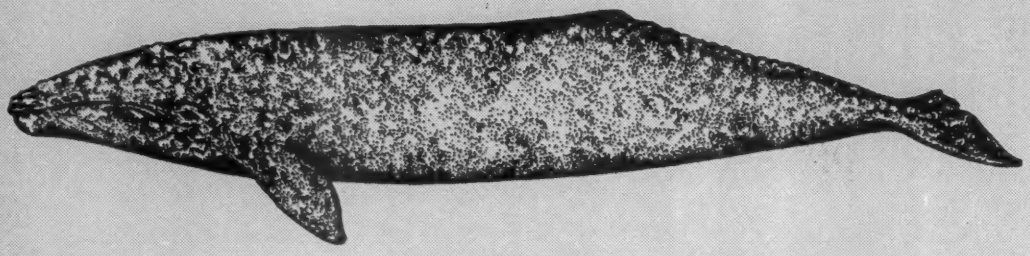
Thursday, October 27— The whales have not swum to open water. They are still about one mile from the open-water lead. The chain saw crews go into action again and the Soviets promise to make a final series of passes toward the last breathing hole. Morris orders everybody off the ice and asks the Soviets to begin their final passes.

Friday, October 28— TASS reports the Soviets see the whales following the icebreaker into open water. This is the last time they are seen.

Epilogue— By mid-morning, October 28, when it is light enough to fly, several aerial searches take place, but cannot locate the whales. However, open water stretching to the horizon and several "whale tracks" leave rescuers confident that the whales have found a lead and are swimming comfortably. Favorable weather and ice conditions continue for the next several days. National Weather Service ice expert Hufford examines NOAA satellite pictures and concludes that there is a continuous series of leads, at least half a mile wide, almost all the way to open water in the Chukchi Sea. These favorable conditions prevail at least until November 4th, and possibly beyond.

NOAA's David Withrow, commenting on the whales' prospects as they face an 8,000-mile journey to their Baja breeding grounds, is quoted by United Press International as saying "They can just boogie now."

The Gray Whale



Gray whales are found only in the North Pacific: a western stock off the eastern coast of Asia, and the more familiar "California" or eastern stock, found along the west coast of North America. Adult grays range in length from 35 to 50 feet and weigh between 16 and 45 tons. The three gray whales trapped in Alaska were all quite young. The oldest was probably only 3 or 4 years.

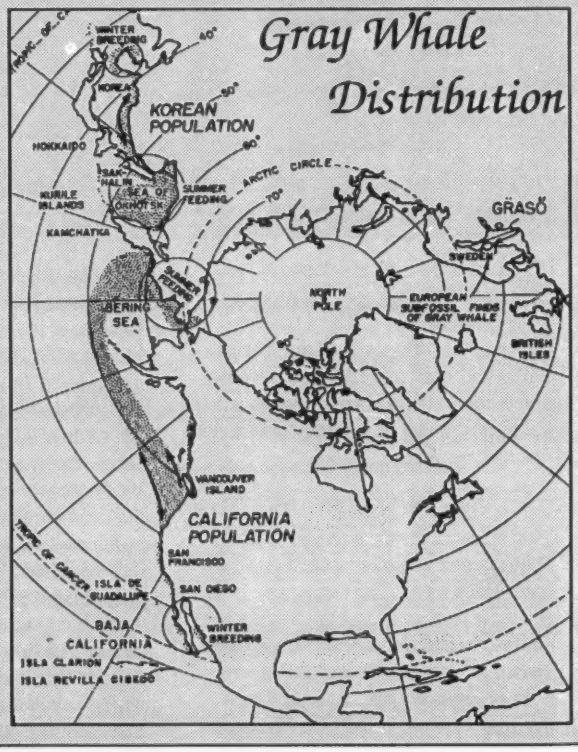
The California stock spends its summer feeding on crabs, shellfish and other bottom-dwelling animals in the northern Bering and southern Chukchi seas. In October and November, the grays begin to leave Alaska, hugging the shore on their migration to southern California. Surviving exclusively on the fat stores accumulated earlier in the year, they travel about 135 miles a day.

The stock breeds during its migration so that by the time it arrives off the coast of Baja California, where it will winter, a fair number of females are pregnant, although because gestation is just over a year— about 13 and one-half months— only those females pregnant from the previous year's season will give birth.

Calves, which arrive in late January and throughout February, weigh about a ton and will nurse for around 7 months.

Grays were commercially exploited as far back as 1846. Gray whale hunting peaked from 1855 to 1865, when the annual catch averaged 474 whales. Commercial hunting was banned in 1946 by the International Whaling Commission, although several hundred grays have been killed since then for scientific study and as part of the Soviet Union's native subsistence hunt.

Chiefly because of international protection, the gray whale has made a spectacular comeback. Biologists estimate that its population is now between 14,000 and 20,000, close to what it was before commercial hunting began.



SPECIAL NOTICE

OCEANOGRAPHIC ATLAS of the INTERNATIONAL INDIAN OCEAN EXPEDITION

by Klaus Wyrtki

The National Oceanographic Data Center (NODC) is pleased to announce that the *Oceanographic Atlas of the International Indian Ocean Expedition* by Klaus Wyrtki originally published in 1971 by the National Science Foundation has been reprinted by Amerind Publishing Co. in India. Based on all available data from the Indian Ocean collected from the mid-1920s to 1966 (with the exception of a few cruises omitted for various reasons), the Atlas had been unavailable since the initial printing was exhausted. The Atlas displays major oceanographic variables in color-coded maps; it contains 531 pages (15 1/2 x 12 inches.) Copies of the reprint are now available from the NODC for a mailing and handling fee of $15.

Orders must be prepaid by check, money order, or credit card (Visa and MasterCard only). Purchase orders can be accepted only with prior authorization from the NODC. Credit card orders must include the card number, expiration date, and name of the card holder exactly as it appears on the card. Checks and money orders should be made payable to "Dept. of Commerce/NOAA/NODC"; payments must be in U.S. dollars and drawn on a bank located in the United States. Orders should be directed to:

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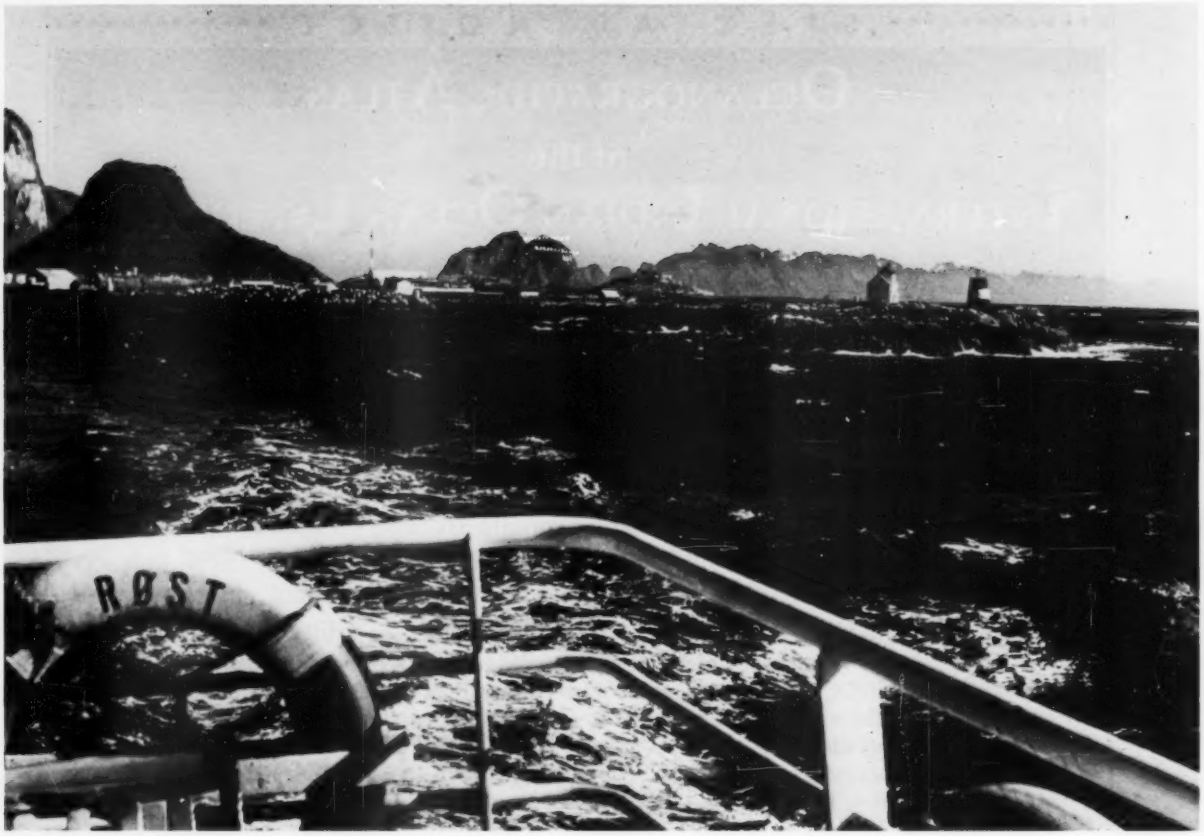


Looking north toward Mosken Island and the mountainous Moskensøy beyond. Between the two islands lies the legendary Malstrøm, part of which can be seen to the right. Photo courtesy of P.A. Røstad-Foto, Oslo.

Malstrøm—the Legend and the Reality

Michael J. Mooney

> *"The edge of the whirl was represented by a broad belt of gleaming spray; but no particle of this slipped into the mouth of the terrific funnel, whose interior, as far as the eye could fathom it, was a smooth, shining, and jet-black wall of water, inclined to the horizon at an angle of some forty-five degrees, speeding dizzily round and round with a swaying and sweltering motion, and sending forth to the winds an appalling voice, half shriek, half roar, such as not even the mightiest cataract of Niagara ever lifts up in its agony to heaven ..."*

Thus did Edgar Allan Poe describe one of the great and fearsome natural wonders of history and legend in his chilling narrative, *A Descent Into the Maelstrøm*. The Maelstrøm, or more correctly Malstrøm, occurs in the southern Lofoten Islands off Norway's west coast.

Though **Malstrøm** was first used to describe this stellar Norwegian natural phenomenon, its meaning has since spread to encompass all sizable whirlpools and even widespread turmoil in general—having nothing to do with the sea. Actually, the term originally came from the Dutch **malen**, "to grind or whirl," and **stroom**, or "stream," hence— "grinding stream." This complements one of the more picturesque legends surrounding the Malstrøm, where two millstones aboard a ship transiting this sea-passage ground out so much salt that the ship foundered. Accordingly, the millstones continued to grind away underwater, causing nearby waters to become turbulent and salty.

Near Bodø, a popular mainland tourist center 55 miles southeast of the Malstrøm, there is a lesser known but sometimes more torturous stretch of swirling water called the Saltstraumen, which connects the Saltfjord and Skjerstadfjord. At every change of tide a tremendous amount of water surges through this narrow channel with a roar that can be heard miles away. Even the horizon has an unnatural fullness, like a bowl filled to the verge of overflowing. Comparing the Malstrøm to the Saltstraumen on a day-to-day basis, one would tend to favor the Saltstraumen. But, for singular displays of unmatched oceanic fury, given the proper conditions of wind and tide, the Malstrøm reigns supreme.

The Malstrøm harks back to the legends and superstitions of the Middle Ages.

Whirlpools are rotary masses of water that spin rapidly about a central, usually depressed, core or maw. Centrifugal force often creates a visually fearsome funnel effect causing the sides of the whirlpools to well up alarmingly. At times the water itself disappears through a central cavity to a lower chamber, giving the false impression of a ravenous, bottomless abyss.

There are also other famous whirlpools. The Charybdis whirlpools, of Homeric fame, occur in the Strait of Messina between the toe of the Italian "boot" and Sicily. Fluctuating waters of the adjacent Ionian and Tyrrhenian Seas converge tumultuously in the Strait during regular changes in tide. In Japan the Naruto Strait displays this phenomenon when opposing tidal movements bring together waters from the nearby Inland Sea and the Pacific Ocean.

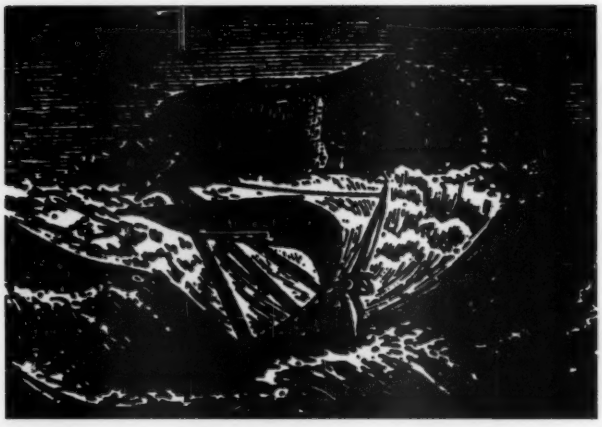
Whirlpools occur most frequently in comparatively shallow water passages connecting two larger bodies of deeper water with differing circulation patterns. Under ideal and unobstructed conditions, whirlpools rotate counterclockwise in the northern hemisphere and clockwise in the southern due to the earth's rotation. However, local topographic/hydrographic conditions often override this natural tendency. A variety of physical conditions can generate or perpetuate whirlpools. These usually include: the confluence of opposing tides, currents, and winds; outcropping rocks and reefs; underwater irregularities; natural hydrographic gradients; gravity; or any combination of these elements. Samuel Carter III, in *Kingdom of the Tides*, supports the tidal theory, stating that: *"whenever and wherever the rhythmic flow of tide is interrupted, for one reason or another, it turns perverse and reacts with trickiness and, sometimes, violence."*

The Malstrøm harks backs to the legends and superstitions of the Middle Ages. In the late 16th century, the English geographer Richard Hakluyt first mentioned the Malstrom in, *The Principal Navigations, Voyages, Traffiques and Discoveries of the English Nations.* He tells how, in the year 1360, the Franciscan friar Nicholas de Lynna voyaged to the forbidding subpolar regions north of England in the reign of Edward III. Hakluyt relates:

"... there is a certain woonderful whirlpoole of the sea, wherein to all the waves of the sea from farre have their course and recourse, as it were without stoppe: which, there conveying themselves into the secret receptacles of nature, are swallowed up, as it were, into a bottomlesse pit, and if it chance that any shippe doe pass this way, it is pulled, and drawen with such a violence of the waves, that oftsoones without remedy, the force of the whirlpoole devoureth the same."

The Malstrøm first appeared in Mercator's atlas in 1569. In 1645 an event of great magnitude occurred on Sexagesima Sunday. On the fateful morning the Mal-

Local inhabitants fishing in the Saltstraumen. Photo courtesy of the Norwegian Travel Office.



An artist's woodcut of a local sailing craft caught in the Malstrøm.

strøm unleashed its full fury, emitting a stupendous earth-shaking roar that reportedly damaged villager's homes and tumbled stone walls to the ground on nearby Mosken Island.

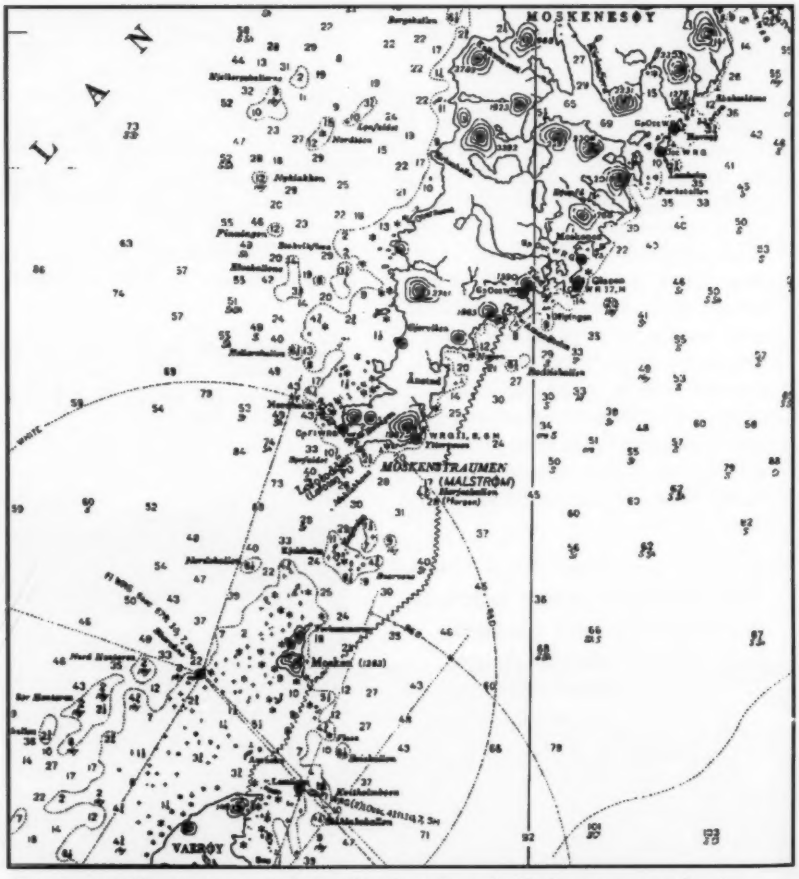
The Malstrøm has been immortalized by a number of illustrious writers over the years, including Jules Verne, the Norwegian poet Peter Dass, and of course, Edgar Allan Poe, whose unforgettable 1841 classic, *A Descent Into the Maelstrøm*, remains unchallenged as the most fearsome, albeit exaggerated, account of the phenomenon.

In Poe's tale the old fisherman gave a most descriptive picture of the Malstrøm. He and two brothers, went fishing in the Malstrøm timing their stay with a periodic slack between the changes of tide. This time, however, his watch stopped and the boat was caught in the forming whirlpool. To compound their dilemma, a sudden storm of hurricane intensity magnified the Malstrøm to unbelievable proportions. This is what he saw after the boat tipped out of control into the dish of the monstrous whirlpool:

"Never shall I forget the sensation of awe, horror and admiration with which I gazed about me. The boat appeared to be hanging, as if by magic, midway down, upon the interior surface of a funnel vast in curcumference, prodigious in depth, and whose perfectly smooth sides might have been mistaken for ebony, but for the bewildering rapidity with which they spun around, and for the gleaming and ghastly radiance they shot forth, as the rays of the full moon... streamed in a flood of golden glory along the black walls, and far away down into the inmost recesses of the abyss."

In real life, the Malstrøm is a huge carpet of active tidal water located in the southern Lofoten Islands, off the northwest coast of Norway, near 12°51'E and 67°48'N — 90 miles north of the Arctic Circle. The surrounding seas comprise some of the best fishing grounds in northern Europe. The Malstrøm is also a famous sea-passage connecting Vestfjord and the unpredictable Norwegian Sea, measuring nearly 5 miles across, with the islands of Moskenesoy to the north and Mosken to the south. In mid-channel are two rocky islets called Kjeldholm and Hogholm. At the eastern end is Herjeskallen, an underwater skerry or submerged rock, less than two fathoms down, which causes local turbulence even in calm weather.

The main channel between the two "holms" and Moskenesoy is about 3 miles wide and forms a relatively shallow "saddle" separating the far deeper waters to the east and west. The sea bottom of the Malstrøm is rocky and sandy with irregular soundings between 10 and 31 fathoms, barring shoals. In contrast, depths exceeding 100 to 200 fathoms are found a short distance "offshore" in either direction.



This Defense Mapping Agency hydrographic chart shows the Moskenstraumen and environs.

The *Sailing Directions for the Northwest and North Coast of Norway* provides a comprehensive overview of the local tides, winds, and currents that give the Malstrøm its famous reputation: *"Though rumor has greatly exaggerated the importance of the Malstrøm, or more properly Moskenstraumen, which runs between Mosken and Lofotodden (on the southern tip of Moskenesoy), it is the most dangerous tideway in Lofoten, its violence being due, in great measure, to the irregularity of the ground, which rises rapidly from the westward toward the east end of the Straits while on the south side the currents are obstructed by the bank northward of Vaeroy. The current attains its greatest velocity, which may be estimated at about 6 knots, during westerly gales in winter. Its direction depends very much on the wind and weather; with a westerly gale at sea it often sets continuously to the eastward during both flood and ebb, either, slackening or perhaps remaining quiescent for a short time at high and low water, but soon acquiring fresh strength and resuming its easterly course. If the sea should be getting up, and the tide rising at the same time, the rush of water is considerable, and the channel quite unnavigable. In winter, it often happens that a westerly gale at sea will send a heavy swell in toward the coast while there is clear weather over the land and a steady easterly wind blowing out of Vest Fjorden; at these times the surges swell to an extraordinary height and rage and break with great violence over the whole space between Lofotodden and Hogholm; as the strength of the tide increases the sea becomes heavier and the current more irregular, forming extensive eddies or whirlpools (Malstrøm). During such periods no vessel should enter the Moskenstraumen. It is imprudent to try to force a passage either in or out if the current is adverse."*

When wind and tide meet head on, the awesome thunder of their collision can be heard more than 3 miles away, lending credence to the events of that Sexigesima Sunday morning on Mosken back in 1645.

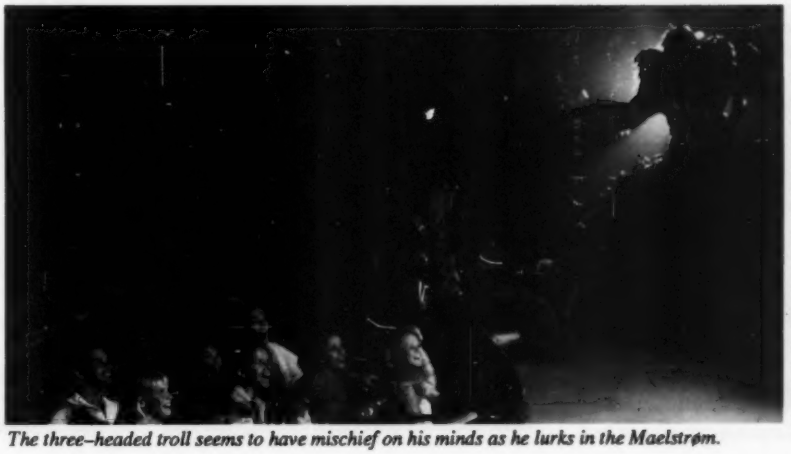
At times the Malstrøm can be deceptively calm and relatively unruffled, leading disappointed vistors to deride the gruesome dangers so often described. During the summer months the Malstrøm is generally on good behavior, particularly during settled weather. In winter, however, it's an entirely different story. This is when the Malstrøm comes into its own, often with a wanton fury harking back to those heroic episodes of the past. If those detractors, who saw the Malstrøm only during periods of calm, came back at the height of a full winter gale, how their views would change.

Granted, Poe did exaggerate a great deal in his interpretation of the Malstrøm. Yet even today this treachous sea-passage poses a very real and possibly fatal threat to the foolhardy in coastal craft who venture too near under certain conditions of wind and tide. The Malstrøm lives today as if it has for untold centuries as an awesome wonder of the sea.

Malstrøm Hits Big Time

Walt Disney has done Edgar Allan Poe one better. This past summer at Walt Disney World's Epcot Center, the Malstrøm came to life in a way that Poe could only imagine. Water trolls, Viking explorers and North Sea storms await visitors to the **Maelstrøm**. Voyagers enter a picturesque courtyard. Waterfalls tumble down granite cliffs beside a Nordic fortress. Inside is a twisting, plunging voyage through Norwegian rivers and fjords aboard a Viking langship.

In the tradition of wooden boats used by Norwegian traders, the 16-passenger boat with its drage hode (dragon head) prow moves along a misty river and into a time tunnel. The fragile boat moves along mountain brooks until a yellow-eyed Nokken (river troll) rears his big ugly head in midstream, blocking passage. Alongside the boat, a three-headed troll exchanges veiled warnings from one craggy face to another causing the boat to reverse course and lurch backward down a waterslide. One of Norway's most romantic and mysterious sights, the Soria Moria Castle, is barely visible through the midnight mist. After negotiating a rocky gorge above Gieranger Fjord, the voyagers face disaster as the boat teeters on the brink of a waterfall. Just in time, a rock-like troll materializes in the waterway and turns the boat down a precipitous waterway into the midst of a storm at sea. Wind and waves batter the voyagers as their tiny craft narrowly misses the piers of a huge North Sea oil rig. Flashes of lightning guide the way to calm waters and safe harbor in a typical south coast Norwegian village. Eat your heart out Edgar!

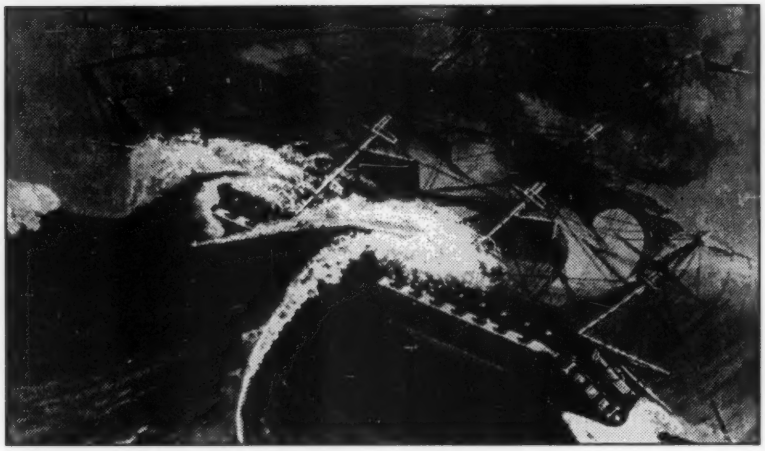


The three-headed troll seems to have mischief on his minds as he lurks in the Maelstrøm.

Use a proven Navy technique and the latest research to:

Avoid the Typhoon

Jerry D. Jarrell
Science Applications International
and
Ted L. Tsui
Naval Environmental Research Prediction Facility



"Tho I have never been in any hurricane in the West Indies, yet I have seen the very image of them in the East Indies, and the effects have been the very same; and for my part I know no difference between a hurricane in the West Indies and a tuffon on the coast of China in the East Indies, but only the name. And I am apt to believe that both words have only one signification, which is a violent storm."

So wrote William Dampier, a late 16th century buccaneer who lived and worked with some of the rowdiest pirates in history. But he was a student of nature in general and weather in particular; his intelligence enabled him to become one of the top navigators of his day.

Dapper William Dampier by Thomas Murray.

Observation of tropical cyclones by mariners over the centuries has led to a knowledge of their nature and, gradually, to methods of avoiding them.

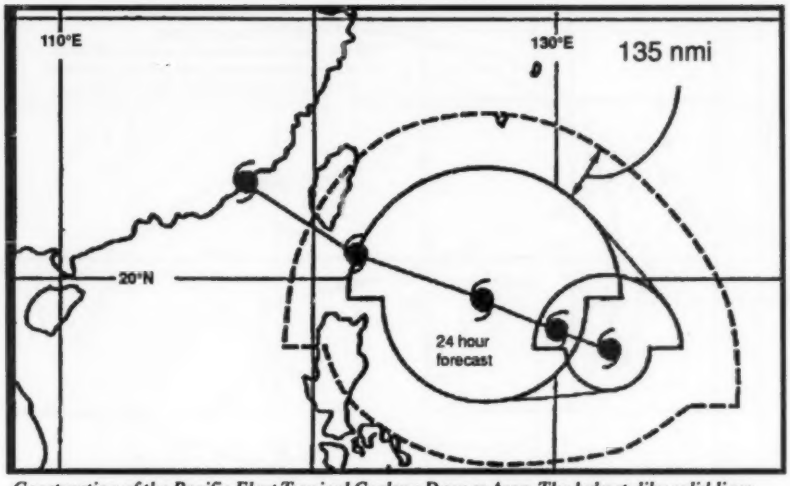
If you regularly sail the western North Pacific there's an excellent chance you will encounter a tropical cyclone. In 1987, for example, there were 25 storms and 139 days with warnings. In the old days signs of tropical cyclones were read from the sky and water. Today they come via radio and facsimile. How these warnings are used often determines the ease of the voyage and sometimes safety of crew and vessel. You may find the Navy's method of tropical cyclone avoidance useful for your own situation.

Problems arise when trying to avoid typhoons and several methods have been used. Because tropical cyclones rarely move toward the equator in either hemisphere, a popular evasion tactic is to head in this direction. This often requires crossing the forecast track ahead of the storm. The fundamental problem with this maneuver, called "crossing the T," is remaining far enough ahead to avoid dangerous winds and seas. Such seas could slow progress to the point where the evasion becomes a rendezvous. In these front quadrants of a tropical cyclone, without evasive action, a ship can be overtaken by progressively worsening conditions. Additionally, in the right front quadrant (Northern Hemisphere) the winds and seas also tend to force the vessel toward the cyclone's central core. Moving in behind a typhoon could unwittingly expose a vessel to a loop or u-turn, which would rarely be forecast.

The U.S. Pacific Fleet transmits a tropical cyclone Danger Area. Using the Danger Area to avoid tropical cyclones has three important advantages. It is easy to understand, communicable, and it works. For example, remaining ahead of the Danger Area minimizes the problem of "crossing the T." Also, the Danger Area signals a ship's captain when he has cut it too close and is in jeopardy.

... the underlying purpose is to keep ships out of dangerous areas where fully arisen seas in excess of 30 feet are possible.

Construction of this Danger Area begins with 30-knot wind radii drawn around both the present and 24-hour forecast positions. Then, the 24-hour radius is increased by 135 nautical miles to include the average 24-hour forecast error. The danger area is completed by enclosing the space between these wind areas with tangent lines. While the apparent objective is to keep ships out of 30-knot winds, the underlying purpose is to keep ships out of dangerous areas where fully arisen seas in excess of 30 feet are possible. In fact, 50-knot winds more closely represent actual danger to smaller ships; however, 30-knot



Construction of the Pacific Fleet Tropical Cyclone Danger Area. The helmet–like solid lines are the present and 24–hour, 30–knot wind area estimates. These are enlarged by 135 nautical miles to cover an average forecast error. The dotted line then represents the original Danger Area.

winds and the accompanying seas reduce the maneuverability of ships and therefore the capability to avoid dangerous conditions.

There have been recent suggestions to decrease the 135–nautical mile safety net to 120 nautical miles...

There are also several criticisms of this area that the mariner should be aware of. The Danger Area provides an unknown confidence. It does not correctly reflect the uncertainty in the important elements of a forecast; this can lead to excessive over or underwarning. The use of the Danger Area does not reflect natural bias in forecasts since errors to the right or left are not usually equally likely. Also, it does not consider errors in the present estimate or forecast of the 30-knot wind area, which is the weakest part of the warning. There have been recent suggestions to decrease the 135 nautical mile safety net to 120 nautical miles, which is closer to the average forecast error of the past decade. This has prompted an evaluation of the Danger Area and an analysis to see if it could be improved.

To determine how well they work, Danger Areas were tested from a sample of the Joint Typhoon Warning Center's 1982 forecasts. Three measures were used to evaluate the Danger Area: the Overwarning Rate, Rate of Containment and the Periperal Risk.

1. **Overwarning Rate (OR)**— the ratio of the forecast Danger Area to the observed Danger Area after 24 hours.

2. **Rate of Containment (RC)**— the ratio of the correct area to the observed area of 30-knot winds. The correct area is that area where both the observed and forecast 30–knot wind areas overlap.

3. **Peripheral Risk (PR)**— the risk of encountering 30-knot winds at the edge of the danger area; measured by the average probability around the border.

The test sample was divided into three categories of forecast difficulty— *easy, average* and *difficult*. *Easy* forecasts were assigned to tropical cyclones in low latitudes, usually small but intensifying and growing. Tropical cyclones whose forecast are of *average* difficulty includes formative and mature storms near recurvature. The most *difficult* tropical cyclones to forecast are those that have recurved. They tend to be large and fast moving.

The Peripheral Risk is the most relevant measure of goodness, since it is sensitive to Danger Area edges.

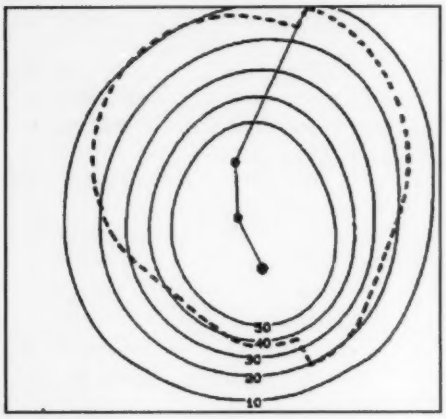
Table 1 summarizes the test results of the 1982 forecasts. The average forecast error of the tropical cyclones ranges from 107 to 136 nautical miles, which is within the ballpark of the 120–nautical mile average error over the past decade. Optimum Overwarning Rates have been determined to be in the 2.0 to 3.0 range to include allowances for size and location of the 30–knot wind area. In the *easy* category the Overwarning Rate is small since small tropical cyclones are usually understated in size. The *difficult* category has a small rate because the 135–nautical mile allowance makes up a relatively small portion of the Danger Area, especially compared to the *average* category, where rates are highest.

The Rate of Containment reflects the level of safety afforded by the Danger Area. It is highest in the *easy* class where position errors are small. In the *average* category the rates were less than average

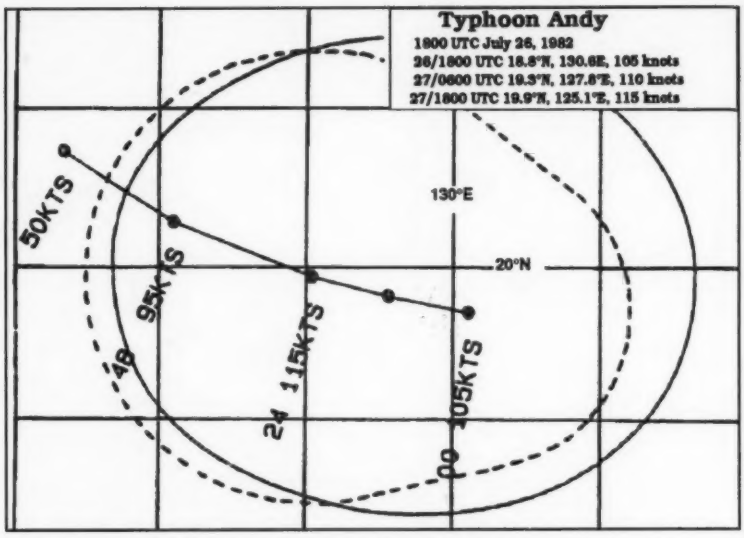
Table 1.— Checking the Original Danger Area Forecasts

OR - Overwarning Rate
RC - Rate of Containment
PR - Peripheral Risk.

Class	#Fcsts	Cyclones	Avg Error	OR	RC (%)	PR(%)
Easy	61	16	110	2.4	95.5	38
Average	65	22	107	3.3	91.7	25
Difficult	56	22	136	2.6	91.6	30



This depicts the danger area (dashed line) compared to the 30–knot wind probability contours. The average peripheral risk of 30–knot winds ranges from about 9% at top left to about 43% lower left. The overall average is about 21%.



Typhoon Andy in the Philippine Sea, July 1982. Solid circle is the nowcast position (1800 UTC, July 20), while open circles are the 12, 24, 48 and 72–hour forecasts. The large area enclosed by heavy dashed line is the current danger area, while the area enclosed by the solid line is the contour of 30% probability of 30–knot winds. Forecast is in the easy category.

because actual errors were relatively large. The rates were similar to those of the *difficult* class.

The Peripheral Risk is the most relevant measure of goodness since it is sensitive to Danger Area edges. In the *easy* category the small size of the Danger Area allows the highest risk (38%) of encountering 30–knot winds at the periphery. These percentages are averages and vary from storm to storm. For example, in the *average* category the risk in individual storms ranged from 7% to 46%, while in the *difficult* class the range was from 13% to 61% in individual cases.

If the 135–nautical mile allowance for error were changed to 120 nautical miles, there would be a decrease in both the Overwarning Rate and Rate of Containment, but an increase in the Peripheral Risk factor.

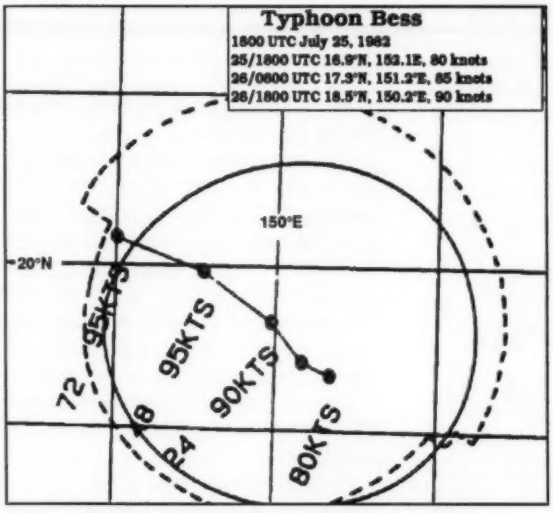
From these tests the following results were determined. If the 135–nautical mile allowance for error were changed to 120 nautical miles, there would be a decrease in both the overwarning rate and rate of containment, but an increase in the Peripheral Risk factor. The criticism that the Danger Area is inconsistent, overwarning in small error areas and underwarning in large error areas was not confirmed by the tests. The degree of consistency, in the sample tested, was surprising. The criticism that the Danger Area does not reflect the natural bias in forecasts, with errors to the left or right not always equally likely, was not tested but was not contradicted by the results.

It might be supposed that the Peripheral Risk would be lowest for easy forecasts and higher for the more difficult forecasts. What was found was, in fact, just the opposite. If you enter the Danger Area the likelihood of encountering 30-knot winds is highly variable depending on sector entered, forecast difficulty, and forecast size. What was confirmed, in part, was the fact that the Danger Area does not consider errors in the 30-knot wind forecast area. This is important to the development of an improved Danger Area.

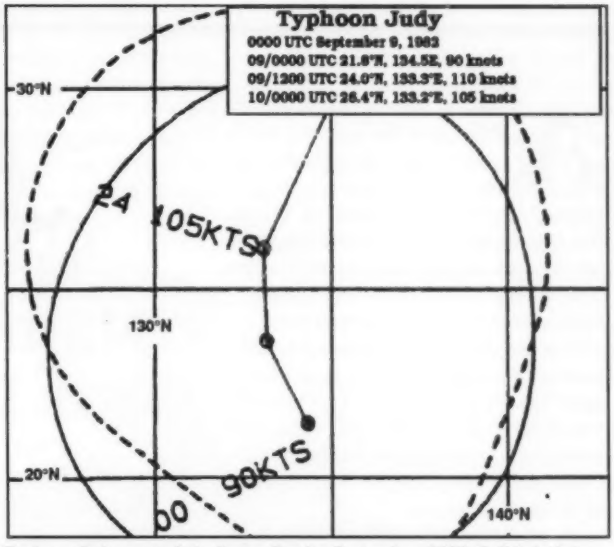
A particular 24-hour, 30-knot wind probability contour should be an ideal delimiter of a Danger Area. It would standardize the Peripheral Risk of 30-knot winds in all cases and would allow for errors in both position and wind radii. This was tested on the same set of 1982 forecasts from the Joint Typhoon Warning Center that was used to evaluate the original Danger Area.

This new Danger Area does not compromise the desirable features of the old Danger Area...

The figures of Typhoons Andy, Bess and Judy show the comparison of the the original Danger Area with the 30–knot forecast area (30% probability of 30–knot winds in 24 hours). An analysis similar to that done for the original Danger Area is shown in table 2. Immediately apparent is the standardization of the Peripheral Risk. The effect of this is to generally increase the size of the Danger Area around the present position, decrease it somewhat around the 24-hour forecast, and skew the remainder slightly to the right. In effect, we are trading off some allowance for 24-hour forecast effort for present error, particularly in the 30-knot wind radius. We are also acknowl-



Typhoon Bess in the mid Pacific, east of Guam, July 1982. Solid circle is the nowcast position (1800 UTC, July 25). The open circles are the 12, 24, 48 and 72–hour forecasts. The large area enclosed by heavy dashed line is the current danger area, while the area enclosed by the solid line is the contour of 30% probability of 30–knot winds. Forecast is in the average category.



Typhoon Judy east of the Luzon Straits, September 1982. Solid circle is the nowcast position (0000 UTC, September 9). The open circles are the 12, 24, 48 and 72–hour forecasts. The large area enclosed by heavy dashed line is the current danger area, while the area enclosed by the solid line is the contour of 30% probability of 30–knot winds. Forecast is in the difficult category.

edging a preference for certain types of errors depending on forecast difficulty class. For example, in the *easy* class the most serious source of errors is in the 30-knot wind radius. In the *difficult* class, the most serious error is in the forward speed.

This study has provided an alternative definition of the Danger Area.

The Rate of Containment for *average* and *difficult* forecasts was decreased slightly by assuming more risk at 24 hours and less at forecast time. This new Danger Area does not compromise the desirable features of the old Danger Area and yet is a more realistic treatment of the risk encountering a tropical cyclone. The Navy Danger Area has some very desirable features such as simplicity and understandability. On the average it does a splendid job of minimizing danger to ships. It does not, however, use all the information implicit in a tropical cyclone warning. This study has provided an alternative definition of the Danger Area. We recommend that the 30 percent probability of 30-knot winds would be a suitable delineator for the Danger Area. This definition is also consistent with the degree of risk incurred on its periphery. When the official tropical cyclone track forecasts improves, the system can be easily updated to incorporate the improvements.

Also, IBM compatible or MacIntosh personal computer models have been developed to plot the forecast on a geographical background and add the contour of 30 percent, 24-hour, 30-knot wind probability.

While the cost of re-training Navy personnel may forbid the adoption of this technique, there is nothing to prevent the merchant mariner from benefitting from this study. In any case, the use of either Danger Area should help the mariner in avoiding a close encounter of the worst kind— an encounter with a typhoon.

Table 2.— The New Danger Area
(defined as the contour of 30% probability of 30-knot winds.)

WP– 30–knot Wind Probability

Class	#Fcsts	Cyclones	OR	RC (%)	WP (%)
Easy	61	16	3.1	96.8	30
Average	65	22	2.8	87.4	30
Difficult	56	22	2.8	89.7	30

This article was based on a study done under contract by Science Applications International Corporation for the Department of the Navy. It was monitored by the Naval Environmental Prediction Research Facility. The study is entitled: ***Tropical Cyclone Ship Avoidance Program for the Western North Pacific Ocean****. Jerry D. Jarrell, who was working for SAI at the time of the report has recently taken a position at the National Hurricane Center. Ted Tsui of the Naval Environmental Prediction Research Facility, has been a frequent contributor of tropical cyclone data to the* ***Mariners Weather Log****.*

Matinicus Twin Lights

Elinor DeWire
Mystic Seaport Museum
Mystic, CT 06355

A sailor approaching lonely Matinicus Rock in the 1800s might have thought he was seeing double. This dangerous, 32-acre ledge, 23-miles off the coast of Maine, had twin lighthouses on it in those days, two wooden towers with two bright beacons in their crowns and a small, cobblestone keeper's dwelling between them.

When the government marked this notorious peril at the entrance to busy Penobscot Bay, it was decided two beacons would serve better than one. The idea was not to produce twice as much light, rather to distinguish the station from neighboring beacons.

A surge of lighthouse construction in the late 1700s and early 1800s had resulted in a string of much-needed sentinels, stretching from the Canadian Maritimes down to the Florida Keys. But all of these lights were white and fixed, and anyone not intimately familiar with the coast easily mistook one light for another.

The simplest answer would have been a system of flashing lights with characteristics signals. A French physicist was at work on this technology about the time Matinicus Twin Lights went into service. It would be another 20 years, however, until flashing lights were adopted for use in U.S. lighthouses.

Colored lights were also a poor substitute, since their beams could not be seen as far at sea as white lights. To solve the identification problem, the Lighthouse Establishment opted for an old European system of using multiple lights in places where there were many beacons in view at once.

Seven twin light stations were eventually built in the United States at places like Navesink, New Jersey; Cape Ann, Bakers Island, and Plymouth, Massachusetts; and Cape Elizabeth, Maine. There was also one triplet station built at Nauset Beach, Cape Cod.

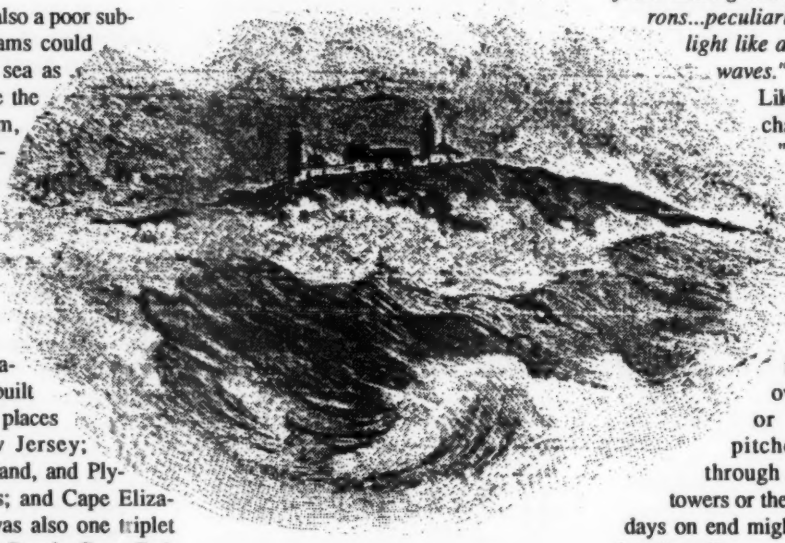
Matinicus Twin Light Station, built in 1827, was among the double beacons which helped ease the confusion between the dozen or more sentinels in the Gulf of Maine.

Matinicus' first towers, flimsy wooden structures attached to either end of the keeper's house, deteriorated quickly. Within a decade they were replaced with more substantial stone towers. The continual pounding of sea against the rock soon undermined these new towers and sent architects back to their drawing boards for a third try.

This time, granite blocks were carefully hewn and the courses tightly bound together to form two cylindrical towers that still stand sturdy today. These were built about 180-feet apart, since research had revealed twin lights placed too close together tended to merge into one beam when viewed from just a few miles offshore. Due to the severe weather on Matinicus Rock, each tower was connected to the keeper's dwelling by a covered passageway.

The station was soon dubbed one of Maine's most attractive, though it was also called the most desolate because of its distance from the mainland. Life was hard there— a world of gray boulders, gray sea, and gray towers. Rough seas made trips ashore almost impossible for the better part of each year. Keepers learned to make provisions and oil stretch, since the supply vessel sent by the Lighthouse Service could seldom make a landing.

Still, passerby and short-term visitors found it an idyllic spot. Journalist Gustav Kobbe, writing for **Century Magazine** in the 1880s described Matinicus Twin Lights as: *"Rising with an antique grace from among their picturesque environs...peculiarly fitted to shed their light like a benediction upon the waves."*



Likely Kobbe would have changed this opinion of "The Rock", as many keepers nicknamed Matinicus, if his visit had lasted more than a few days or coincided with the arrival of a horrendous Nor'easter. Seeing storm waves crash over the keeper's house, or hearing the high-pitched shriek of wind through every crevice in the towers or the fog signal droning for days on end might have turned "grace" into "gruel".

Among the earliest families to live at Matinicus Twin Lights were the Burgesses. Their heirs would occupy the station for generations. Patriarch, Samuel Burgess, was appointed lightkeeper in 1853, and with him to the rock came his invalid wife and five children. The oldest child, a son, soon left to work with local fishermen, leaving the greater burden of help to the next oldest child, a girl of fourteen named Abbie.

Though of slight build and condemned to wear a skirt, Abbie diligently learned to handle the station boat and tend the two light towers, in addition to doing the house chores her mother was unable to do. When Abbie's father was away, which he frequently was due to his wife's need for medicine, Abbie alone tended the lights and cared for her younger sisters and mother. By all reports, she did an expert job, and her courage and devotion to the lights earned her special praise from New England seamen.

In January 1856, when Abbie was seventeen, a severe spring storm swept up the Maine Coast. The day before, Keeper Burgess had rowed to little Matinicus Island, 9-miles away, to get supplies. He was unable to return for four weeks due to rough seas, but every night he looked across the turbulent water separating him from his family and saw the twin lights shining brightly. Abbie kept the lamps clean and burning, even when the sea washed into the house and forced her to move the family into one of the light towers.

Abbie's joy were the hens she raised in a coop at the north end of the rock. They provided eggs for the family, but they were also pets. During the famed 1856 storm, Abbie braved hurricane wind and spume to rescue the hens. A year later, during another storm when she again tended the lights alone, the eggs laid by the hens kept the family from starvation.

Because lightkeepers' positions were, for many years, politically controlled, Samuel Burgess lost his job with the 1860 presidential election, due to his party ties. He turned the lighthouse keys over to Captain John Grant in 1861 and left Abbie at the rock to acquaint the new keeper with the station.

Abbie Saves the Chickens
engraved by Albert Blasse

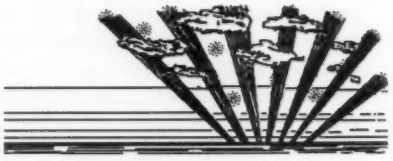
Abbie was by now a handsome woman of twenty-two, and quite skilled at both housekeeping and lightkeeping. Captain. Grant arrived with his son, Isaac, who was to be the assistant keeper. Isaac, a little older than Abbie, was immediately smitten. Abbie's affection for him must have been equal, for the two were married in the lantern of one of the light towers a short time later.

Abbie was appointed 2d assistant keeper. Four children were born before she and Isaac left Matinicus Rock in 1875 to become the keepers of Whitehead Lighthouse, near Rockland, Maine. They served here another 15 years before retiring. Life away from the lights did not agree with Abbie though, and she died a short time later. A small lighthouse marks her gravestone in Maine's Spruce Head Cemetery.

Many keepers have come and gone at Matinicus Rock since Abbie Burgess Grant, but none are so well-remembered. In 1923, a cost-conscious Bureau of Lighthouses discontinued the north beacon at Matinicus Rock and gave the south tower a flashing characteristic. Coast Guard keepers took over the civilian positions in 1939 and tended the single south tower until the 1970s when Matinicus Light was made automatic.

Today, ornithologists and interns in the National Audubon Society's "Puffin Project" occupy the old keeper's quarters.

The rock has become the focus of an exciting experiment to return the Atlantic puffin to its native home in the islands of Maine. This comical seabird, with penguin-like waddle and buffoon face, rears its young in burrows of Matinicus Rock, then flies away to winter at sea. For these creatures, at least the beacon at Matinicus signals a happy future.



Offset Halos

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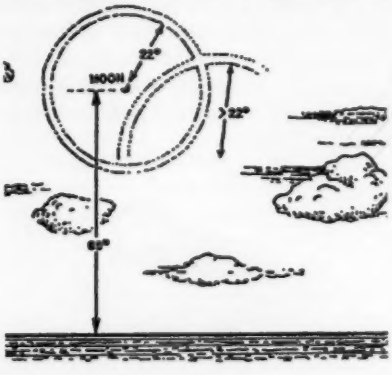
P.O. Box 107
Glen Arm, MD 21057

Halo theory insists that all halos be circular under ideal conditions. However, elliptical, square and even teardrop-shaped halos have been observed. There are also many reports of anomalous halos and arcs. It is often tempting to dismiss these observations as observer errors. Often a slight modification in an observation can turn the unknown into the known. This criticism can be combatted by collecting several good records of the same phenomenon. This has been done with offset halos and some of the curious arcs.

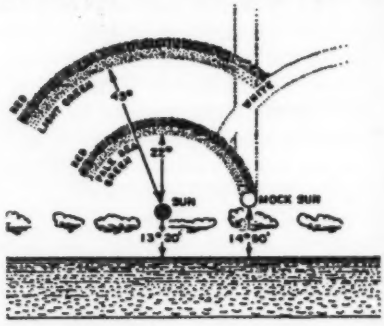
Offset halos and arcs usually require secondary sources of illumination to be explained. Among these light sources are mock suns, mock moons, intersections of halos and arcs, and possibly reflections from clouds and sea surfaces, which act as natural mirrors. Noncircular halos could conceivably be caused by abnormal refraction and changing ice crystal population, but resulting effects would be patchy producing irregular and poorly defined halos.

On March 7, 1950 in the Caribbean Sea a distinct lunar halo of radius 22° was observed. The halo was obscured from time to time by cumulus clouds. At 0640 an arc of a second halo, of apparently slightly larger radius, appeared. It intersected the primary and the outer perimeter and passed to within about 2°of the moon. The secondary was visible for 5 minutes, after which the area became obscured by clouds. After a few minutes the primary was again observed, but the secondary had vanished. The moon, which was 20



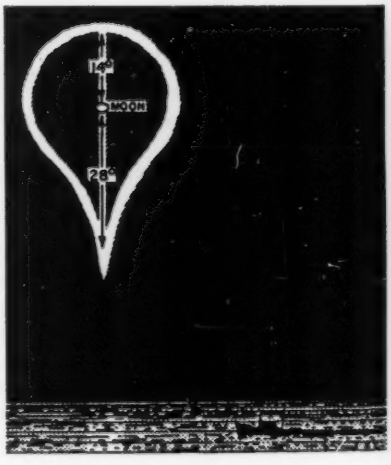
days old, had an altitude of 55°. This is another interesting halo observation which cannot be fully explained. At first sight the arc of the halo intersecting the ordinary halo appears to be a secondary halo. There are, however, two reasons why this cannot be the case: (1) the halo is stated to be of slightly larger radius; and (2) the altitude of the moon is 65°. A secondary halo cannot be formed with an altitude of the moon (or sun) greater than 60° 45'. These offset white arcs closely resemble some of those seen in association with rainbows. It is possible that the offset arc is actually a secondary halo about a mock moon, which could have been obscured by a cloud.

The following report came from the Marine Observer: On the 23d of February 1957 in the South Atlantic Ocean, halo phenomena were seen after sunrise. The radii of the two main halos were 22° and 46°. There was a brilliant vertical ray of light from the mock sun, shown as vertical lines in the sketch, and an arc of a white halo crossing this. Both the main halos were colored, the 46°one red and light green and the 22° one red and pale sea-green. There was cirrus cloud above the 46° halo, altocumulus in bands between the two halos, and altocumulus or high stratocumulus above the 22° halo with a layer of separate cumulus at lower altitude. There appeared to be a difference in altitude between the true sun and the mock sun and, on making careful measurement, the altitude of the lower limit of the true sun was found to be 13° 20' and that of the lower limit of the mock sun 14° 50'. The offset white arc is perhaps the most anomalous aspect of

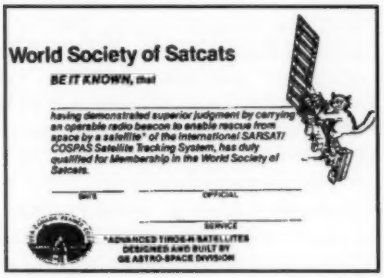


this display, however, the presence of a mock sun pillar in the absence of one from the real sun is unusual, as is the difference in altitude of sun and mock sun.

On September 15, 1976 in the North Pacific an unusually shaped lunar halo was observed to the north northeast. The moon at its, gibbous phase, had a 14° halo which projected outward to a point about 28° from the center. The appearance was that of a very large teardrop. This phenomenon lasted for about 20 minutes after which time the elongation gradually diminished until a perfect 14° halo was achieved. The whole phenomenon was visible for another hour.



SATCATS


World Society of Satcats
BE IT KNOWN, that
having demonstrated superior judgment by carrying an operable radio beacon to enable rescue from space by a satellite* of the International SARSAT/COSPAS Satellite Tracking System, has duly qualified for Membership in the World Society of Satcats.
DATE
OFFICIAL
SERVICE
*ADVANCED TIROS-N SATELLITES DESIGNED AND BUILT BY GE ASTRO-SPACE DIVISION

The **"World Society of SATCATS"** — composed of downed flyers and shipwrecked sailors who "landed on their feet" thanks to life-saving satellites operated by the U.S. and the U.S.S.R.— held its first meeting this week at Vandenberg Air Force Base, CA, as the nation's newest search and rescue satellite, NOAA-H was readied for launch.

Dr. E. Jeff Justis, a Memphis, TN, surgeon rescued with his wife Sally within six hours of a 1986 belly landing on the Greenland Ice Cap, was selected temporary SATCAT chairman. The couple was air-iifted from the frozen 9000-foot-high plateau by a Danish helicopter, using directions radioed by the international satellite search and rescue system known as COSPAS/SARSAT.

COSPAS/SARSAT is serviced by two NOAA weather satellites and two Soviet navigation satellites. Since 1982 it has saved more than 1150 people on four continents Last July in Paris the U.S., Canada, France and the Soviet Union signed an inter-governmental agreement to continue the system into the 21st century.

"We are very enthusiastic about our new organization, the SATCATS," Dr. Justis said. "The COSPAS/SARSAT system is incredibly effective at finding downed planes and vessels anywhere in the world. It has removed the search from search and rescue. We know this first-hand, but we also know that people may not be found if they don't carry a beacon that COSPAS/SARSAT satellites can track.

"We hope to save lives by enlisting hundreds more people throughout the world to join a SATCAT campaign for proper use of emergency radio beacons. "We ask all satellite rescues to contact us," he declared.

The SATCATS have powerful allies. All U.S. commercial fishing vessels will soon carry COSPAS/SARSAT emergency beacons. The Coast Guard this month published rules requiring the U.S. commercial fishing fleet of 127,000 vessels to be operating COSPAS/SARSAT type beacons by August 17, 1989. In addition, the U.N.'s International Maritime Organization (IMO) is expected to vote this fall on requiring the world's fleet of 60,000 merchant vessels to carry them.

The problem tackled by the SATCATS is two-fold: failure to carry such signalling devices, and careless maintenance and use of them by pilots and mariners. The FAA already requires all 240,000 U.S. general aviation aircraft to use them; they are optional, however, for seagoing private vessels.

A group of SATCAT charter members was introduced at a COSPAS/SARSAT news conference in San Francisco Thursday, Sept. 22, which featured a Coast Guard demonstration of a satellite-assisted rescue in the Bay near the Golden Gate Bridge. The demonstration helicopter rescue simulated airlifting the crew from a burning fishing vessel.

Other SATCATS attending the news conference included Joseph and Jan DeJulius, who operate the DeJulius Electric Company in Novata, Calif., who were rescued from their capsized trimaran in the stormy Pacific last January 300 miles off the Mexican coast, and Patrick Martin, a Seattle, Wash. fishing boat captain who was assisted in 1986 when his vessel encountered engine trouble in heavy seas in the North Pacific between Hawaii and Alaska.

The satellite rescue system was started as an experiment by NASA in the late 1970s. The U.S. segment, known as SARSAT, is now operated by NOAA.

Charter members of the World Society of SATCATS are pictured with Dr. William E. Evans (center), Administrator of NOAA, after he welcomed them into the society. Left to right are: Joseph and Jan DeJulius, Dr. E. Jeff Justis, Mrs. Justis, Dr. Evans, Patrick Martin, Charles Caldwell and Lt. Cmdr. Croom. A good number of merchant seamen throughout the world have qualified for membership in the SATCATS by being rescued with the help of a USA or USSR search and rescue satellite.

NTSB Report

Citing performance deficiencies by the masters of two ferries that collided in fog while crossing Long Island Sound on July 9, 1987, the National Transportation Safety Board (NTSB). called on the U.S. Coast Guard to establish watch and duty time limits for ferry crews.

The NTSB said that, although no link between fatigue and the collision was identified, the Board still was concerned that prolonged work hours by the ferry company's crews "would not facilitate maximum watch–standing vigilance or optimum operating skills."

The two ferries, the ***Cape Henlopen*** and the ***North Star***, collided in dense fog near Orient Point, Long Island, N.Y. Nineteen passengers and two crewmembers aboard the two vessels were injured, three seriously. The collision tore a 30 by 4 foot hole in the bow of the ***North Star***, causing total damage to both craft of $150,000.

The vessels were traveling in opposite directions on routine trips between New London and Orient Point. Both vessels were using fog horns and radar; however, they came in sight of each other when they were only about 40 to 100 feet apart. At the time of the collision, the ***North Star*** was traveling in a southwesterly direction at about 11 knots, while the Henlopen was going 6 to 8 knots.

"The National Transportation Safety Board determines that the probable cause of the collision between the passenger/car ferries M/V ***North Star*** and M/V ***Cape Henlopen*** was the failure of the masters of each ferry, while approaching each other in close quarters in reduced visibility, to reduce speed in accordance with the Inland Navigation Rules to a minimum at which courses could be maintained, and to specify in their meeting agreement, the meeting site and clearance to be maintained," said the NTSB's report.

The Board noted that the ferry owners did not provide written guidance to their masters about maneuvering speed in reduced visibility in close quarters, and the firm did not require them to reduce speed and/or to include more specific information in their meeting agreements. The Safety Board said that had the masters of the two vessels made a more detailed meeting agreement, specifying distance and where they would begin their turn, the masters would have known the other's intentions, and the risk of collision would have been reduced.

The Board observed that there are upper daily work time limits in other commercial transportation modes, but said that Coast Guard rules governing minimum staffing requirements for passenger vessels on extended voyages "will not necessarily influence work time for the short-duration, multiple trip nature of ferry operations."

The Safety Board said the marine industry has established the precedent for setting maximum work hours through federal regulations limiting licensed towing vessel operators from working more than 12 hours in a consecutive 24-hour period. "The Safety Board notes that many more people are likely to be at risk in ferry operations than in most towing operations," said the NTSB report, adding:

"The CSF policy of permitting crewmembers to work four round trips per day on a five-day basis is not conducive to optimum operating performance and, consequently, does not provide the maximum safety to passengers and other vessels in the vicinity." The NTSB continued: "A maximum time crewmembers should be allowed to work would reduce the likelihood of cumulative fatigue and an associated risk of performance degradation among crewmembers of ferry vessel operations."

The Safety Board said the Coast Guard should establish watch and duty time limitations for crewmembers onboard ferries and other inspected passenger vessels.

The Board also recommended that the ferry owners include a requirement in their operations manual providing guidance on how their vessels should meet each other in situations such as the one involving the Henlopen-North Star collision.

The Safety Board's complete printed report will be available in approximately one month. Copies of this report, which should be identified as PB-88-91164006, may be purchased by mail from the **National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.**

Commander Fields

Lieutenant Commander Evelyn J. Fields, NOAA Corps, assumes command of the NOAA Ship ***McArthur*** February 2, 1989, at the NOAA Western Administrative Support Center Center in Seattle, WA. With her appointment, Lt. Cdr. Fields becomes the first woman officer from any of the U.S. uniformed services to command a U.S. commissioned ship of the line. Lt. Cdr. Fields relieves Commander Gerald W. Stanley, NOAA Corps.

The 175-foot research and survey ship ***McArthur***, operating out of the Pacific Marine Center, collects samples of bottom feeding fish and sediments to monitor pollution in U.S. West Coast waters and conducts fisheries surveys and climate research in the Pacific Ocean.

Lt. Cdr. Fields is a commissioned officer in the NOAA Corps. Formed in 1917, the NOAA Corps is the seventh and smallest of the nation's uniformed services, which include the U.S. Navy, Army, Air Force, Coast Guard, Marine Corps, and Public Health Service. It comprises 420 men and

Lt. Cdr. Evelyn Fields

women officers who operate NOAA research and survey ships, fly NOAA aircraft, work in scientific and engineering field parties, and serve in a variety of scientific, technical, and management positions in NOAA.

Honolulu Weather Fax

The Honolulu National Weather Service is earnestly soliciting comments from maritime users on the usefulness of the information on its Honolulu Weather facsimile broadcast and, above all, suggestions for changes and additions to the information transmitted.

This outlet, now on four frequencies simultaneously on 10 Kw transmitters, has recently undergone technical improve-ments. Weather information is provided from 60°N to 25°S between 140° E and 110W. Reliable reception is reported form 2,000 to 3,000 nautical miles and beyond.

Where to Send Your Comments

By Mail:
National Weather Service - W/PR1x1
P.O. BOX 50027
Honolulu, Hawaii 96850

Telephone:
Area Code (808) 541-1659

Radio:
USCG Communications Station Honolulu, (for relay to National Weather Service - PHNLYMH)

AFTN:
PHNLYMYH (Attention W/PR1x1)

AUTODIN;
RUEOLMA/NWS PRH Honolulu
(Attention W/PR1x1)

TELEFACSIMILE:
Area Code (808) 541-1678

Or Pass to any Port Meteorological Officer or Weather Station ashore for forwarding to National Weather Service, Honolulu.

Broadcast Schedule

Time	Area	Valid Time	Chart Description
2333-2345	---	----	Test, ID, and Schedule
2347-2359	PA-25	1800Z	Tropical Surface Analysis
0001-0013	PA-21	0000Z	36-Hour Forecast Weather Map
0015-0027	GOES-W	LATEST	Full disk Infrared Satellite Imagery
0030-0044	PA-21	1800Z	Pacific Weather Map
0046-0058	PA-21	2300Z	Cloud Features From Satellite Imagery
0100-0112	PA-20	0000Z	36 Hour Significant Wave Height Chart
0533-0545	---		Test, ID, and Schedule
0547-0559	PA-25	0000Z	Tropical Surface Analysis
0601-0613	PA-21	1200Z	72 Hour Forecast Weather Map
0614-0627	GOES-W	LATEST	Full Disk Infrared Satellite Imagery
0630-0644	PA-21	0000Z	Pacific Weather Map
0646-0658	PA-21	0500Z	Cloud Features From Satellite Imagery
1103-1115	---		Test, ID, and Schedule
1117-1129	PA-25	0600Z	Tropical Surface Analysis
1131-1143	PA-21	0600Z	Pacific Weather Map
1145-1157	GOES-W	LATEST	Full Disk Infrared Satellite Imagery
1200-1214	PA-21	1200Z	36-Hour Forecast Weather Map
1216-1228	PA-21	1100Z	Cloud Features From Satellite Imagery
1230-1242	PA-20	1200Z	36-Hour Significant Wave Height Forecast
1748-1800	---		Test, ID and Schedule
1801-1814	PA-25	12000Z	Tropical Surface Analysis
1816-1828	GOES-W	LATEST	Full Disk Infrared Satellite Imagery
1830-1844	PA-21	1200Z	Pacific Weather Map
1846-1901	PA-23	1200Z	Surface Analysis
1903-1915	PA-21	1700Z	Cloud Features from Satellite Imagery
1917-1929	PA-26	1700Z	Sea Surface Temperature Analysis

TIMES ARE IN UTC. SUBTRACT 10 HOURS TO CONVERT TO HAWAII TIME

Chart Geographical Limits

PA-20 - from 60N to 05N between 140E and 110W
PA-21 - from 40N " 25S " 160E " 110W
PA-23 - from 60N " 10S " 155E " 115W
PA-25 - from 30N " 50S " 180 " 105W
PA-26 - from 60N " 40S " 100E " 060W

KVM70 Honolulu Radio Facsimile Frequencies

Carrier Frequencies: 9982.5, 11090.0, 16135.0, 23331.5

Tune Communications Receivers to: 9980.6, 11088.1, 16.33.1, 23329.6 USB Mode to allow for the 1.9 KHZ difference between carrier and actual frequencies.

Tuning Variations May Be Required Due To Individual Receiver Characteristics

✍ WLO Mobile Radiofacsimile Users ✍

Your chance to be heard!

Don't Miss it

Major changes coming soon

Broadcast times...Contents...Schedule...Frequency...Areas of Reception
Mariners *Please* pass your comments along to your friendly PMO or write directly to:

National Weather Service
819 Taylor St.
Fort Worth, TX 76102
attn: Steve Rinard
or phone: (817) 334–2652

Michael J. Mooney

In this issue we are pleased to have another article by Michael J. Mooney. Michael is freelancer writer/photographer based in the metropolitan New York area and has been active in non-fiction magazine work for adults and children over the last 19 years.

He has specialized in the environment, especially oceanography, meteorology and other natural phenomena, as well as selective historical and safety subjects.

His work has appeared in: *Alaska, Boating, Child Life, Children's Magic Window, The Compass (Mobil), Good Reading, Kiwanis, The Lion, The Lookout, Oceans, Odyssey, Popular Mechanics, Private Pilot, Ranger Rick, Science Digest, Sea Frontiers, Studio Photography, Take Me Away, and TWA Ambassador.*

Several of Mr. Mooney's articles have been selected and reprinted by the Reader's Digest Association, Oxford University Press, Doubleday & Company, and Danmarks Skibsfart in Copenhagen.

Mr. Mooney is married with two children and served in the U.S. Navy. He is presently employed as Manager, Communications with a large broadcasting company in Manhattan. He is a member of the National Writer's Club and the Society for Children's Book Writers.

Fax Schedule for Pacific

A revised booklet by Lt. Elizabeth White — **Major Marine Weather Radiofacsimile Schedules, Pacific Ocean**— is now available free of charge.

The booklet provides a convenient listing of major marine weather radiofacsimile schedules for the Pacific Ocean. Please note that radiofacsimile schedules sometimes change without notice. This booklet will be updated periodically to remain current with the ever-changing schedules and frequencies. For copies contact:

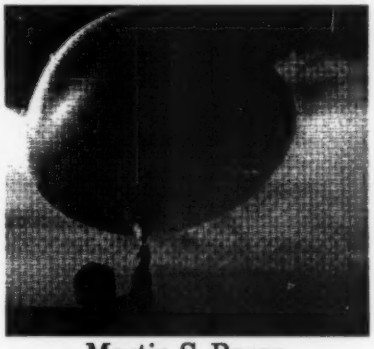
Lt. Elizabeth White
NOAA/Office of Marine Operations
WSC-1, Room 312
6001 Executive Blvd.
Rockville, Maryland 20852
or call (301) 443-8641

How Deep is the Bay— and what's its address?

Last issue, on page 28, we carried a piece on a poster for the bottom of Narragansett Bay. This 18x 24 inch four color poster is generated by computer and was produced by Robert Tyce, associate Professor of Ocean Engineering at the University of Rhode Island Mapping Development Center. Digital depth soundings of the Bay were used to create this realistic 3–D perspective. The striking colors and contours enhance the feeling of "being there." The cost of the poster is a modest $5. Last time we did not list the complete address. Since we received several phone calls of inquiry, there should be a wide interest in the poster. The complete address is:

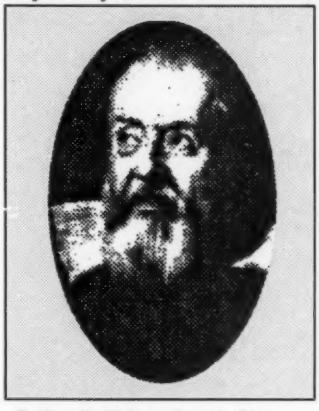
Publications
Rhode Island Sea Grant
University of Rhode Island
Bay Campus
Narragansett, RI 02882

The Thermometer and Barometer— a Brief History



Martin S. Baron
National Weather Service
Silver Spring, MD 20910

It's easy to take for granted an instrument as common as the thermometer, but before the year 1600 it did not exist. An Italian scientist, Galileo, in 1592, is credited with having invented the very first instrument to measure temperature— called a thermoscope. The temperature scales (Fahrenheit, Celsius, etc.) did not exist yet, so the thermoscope only provided relative, or qualitative temperature readings. Galileo assembled a large glass bulb with a long, narrow, open ended neck, and inverted it over a vessel of colored water or wine (alcohol). The expansion or contraction of air in the bulb as the air temperature changed would alter the level of the colored water in the neck. Galileo was on the ball— modern thermometers depend on the expansion or contraction of different substances inside glass envelopes, but use mercury or ethyl alcohol rather than air.



Galileo Galilei was born in Pisa, Italy on February 15, 1564.

The idea of providing such a thermoscope with a scale, thus producing a thermometer that could measure temperature quantitatively, originated with Sanctorious, a colleague of Galileo. In 1611, Sanctorious devised a scale by marking the level of the liquid after placing snow around the bulb, and again by heating the bulb with a candle, and he divided the intervening distance into 110 equal parts. During the next 100 years, many different scientists including Boyle, Newton, and Huygens, used Sanctorious' general idea to produce temperature scales of their own. Two of these scales eventually spread throughout the world and are widely used today— those of Gabriel D. Fahrenheit, and Anders Celsius.

Fahrenheit, a Dutchman of German descent, spent 30 years, between 1700 and 1730, performing experiments in thermometry. He developed the scale bearing his name by submerging his thermometers in what he considered were the key thermal indicators -- boiling water, freshly removed human blood, and cold water as it was freezing into ice. He chose 32 degrees for the melting point of ice, 96 degrees for "blood heat", and 212 degrees as the boiling temperature of water. His unit of temperature was thus 1/180 of the difference between the boiling and freezing points of water. He was the first investigator to use mercury and alcohol in his thermometers.

Celsius, a Swedish astronomer, improved upon the work of Fahrenheit and in 1742, developed a scale more useful to the Scientist. He also immersed the thermometer bulb into boiling and freezing water, but labeled the resulting mercury levels 0 degrees, and 100 degrees, respectively. He then divided his scale into 100 equal units. The scientific community subsequently reversed this order, using 0 degrees and 100 degrees for the freezing and boiling points. This is commonly known as the centigrade scale.

The barometer was invented in 1643 by Evangelista Torricelli, a student of Galileo. The apparatus he used was similar to that used in the thermoscope— a glass tube, 36 inches long, closed at one end, was filled with mercury, inverted, and placed into a mercury container. The open end was closed tightly by a finger while being inverted, so no air got into the tube. When the finger was removed, the mercury in the tube sank until it stood about 30 inches (76 cm) above the mercury in the vessel. Torricelli correctly concluded that the weight of the air acting on the mercury vessel was balancing the 30 inches of mercury, and that the atmospheric pressure equalled the weight of the mercury in the tube. Torricelli very cleverly realized that to measure atmospheric pressure, the space just above the mercury in the tube had to be a vacuum— to ensure that the atmosphere "rested on" the mercury in the vessel, and not on the mercury in the tube. Torricelli's device is practically identical to mercury barometers now in use.

The aneroid barometer, most widely used today, and the type you have aboard ship, was not invented for another 200 years. The honors go to Lucien Vidie, a Frenchman, who first constructed this instrument in 1843. He evacuated the air in a capsule formed by two elastic diaphragms joined at their edges. He could then measure changes in atmospher-

ic pressure as the diaphragm expanded or contracted. He greatly magnified this motion using a system of levers and gears to move an indicator needle on a display panel.

The thermometer and barometer are the two most fundamental meteorological instruments and, until they were available, the science of meteorology was pure speculation. In the 20th century, there has been a proliferation of such instruments. Cooperation, conducted first through the International Meteorological Organization, and starting in 1951, through the World Meteorological Organization, has allowed creation of large scale, "global" observation networks. The Voluntary Observing Ship Program is an example. Cooperative, multinational observation programs are necessary for weather forecasting to succeed. Weather systems cover large areas, and move rapidly around the globe. Modern meteorological theory has advanced as more data has become available. Much remains to be understood— scientists continue to learn and understand more as the study of real time and archived data goes on.

PMO's Receive New Digital Barometers

Torricelli and Vidie would be very impressed! The National Weather Service (NWS) has just purchased new, battery operated, aneroid, Barometer/Altimeter systems from Atmospheric Instrumentation Research, for PMO's to use while calibrating barometers aboard ship. This highly accurate barometer is small enough to fit inside a pocket, and replaces the heavy, Wallace and Tiernan aneroid models that have been used for many years. They have been designed to operate under the wide range of outdoor temperature conditions encountered by PMO's. These instruments display atmospheric pressure in millibars, inches of mercury, millimeters of mercury, pounds per square inch, kilopascals, and inches of water. Unless you instruct the PMO otherwise, he calibrates your barometer to read sea level pressure, as this is used in the ships' synoptic code. If he cannot move the indica tor needle on your instrument, he leaves a "correction to sea level" for you to apply before reporting the reading to the NWS.

The M/V Sea Wolf is the recipient of a new SEAS unit; from left: Second Mate Andy Johnson, Third Mate Rich Miller and Chief Mate Walter Naoolny.

NWS Buys SEAS Units

The NWS has acquired 20 Shipboard Environmental Data Acquisition Systems (SEAS) for installation aboard selected Voluntary Observing Ships. SEAS are communications/data entry devices for sending weather messages via the United States Geostationary Operational Environmental Satellites (GOES). One lucky recipient of a SEAS is the M/V ***Sea Wolf***, operated by American Transport Lines. She will use the SEAS to transmit weather messages on her regular run between the U.S. East Coast and South America.

San Francisco PMO to Retire

Jim Mullick, retired February 1, 1989. He has been PMO in the San Francisco area for the past 8 years. Jim's government career spanned 42 years. This included 32 years with the U.S. Coast Guard, where he rose to the rank of Chief Petty Officer, working in oceanography and meteorology. Jim wishes to convey his appreciation and thanks to all ships' officers that have cooperated with him over the years in the VOS program. He plans to remain in the Bay area for the near future.

New VOS Program Recruits

NWS Port Meteorological Officers recruited 53 vessels into the VOS program during the October–December, 1988 period. Thank you for joining the program. We now have 1406 vessels participating as weather observers. This includes 1331 "high seas" vessels, and 75 "lakers", operating on the Great Lakes. The NWS program is the second largest in the world, next to the Soviet Union with 1410 ships. The World Meteorological Organization (in WMO Pub. No. 47) lists 11 countries with 200 or more weather reporting ships.

Altogether, there are some 7400 vessels worldwide which report weather using the ships' synoptic code, for the VOS programs of 49 different countries.

Weather Reporting Ships
(200 or more)

1. USSR– 1410	5. GR. Brit/N. Ir. - 438	9. India - 256
2. USA– 1406	6. Japan - 341	10. Poland - 234
3. Canada– 471	7. Brazil - 315	11. Yugoslavia - 207
4. Germany (FRG) - 462	8. Netherlands - 314	

Chief Officer N.C. Sorenson of the ***Albert Maersk****, with a new VOS program certificate, as of November 1988.*

Third Officer, Tom Tetard receives his new certificate of membership in the VOS program, aboard the ***President Kennedy****.*

New National Weather Service VOS Ships

ALLIGATOR TRIUMPH	3EIK6	WILLIAMS DIMOND AND CO
ARKLOW ROSE	EIJN	ARKLOW SHIPPING LTD
ATLANTIC	J8QX	TRANSOCEAN MARITIME AGENCIES
BACTAZAR	DUHJ	COMPASS MARINE (U.S.A.)
BUNGA TEMBUSU	9MTW	KERR STEAMSHIP CO.
CANADIAN RAINBOW	3EAF6	AMERICAN TRANSPORT LINES INC.
CHEVRON EQUATOR	D5TP	CHEVRON SHIPPING
COLUMBUS CANADA	DGSR	MATSON AGENCIES INC
EMERALD SEA	LAHA2	COMPASS MARINE (U.S.A.)
EVER GLEEFUL	BKJY	EVERGREEN MRINE CORP
EVER GLOWING	BKJZ	EVERGREEN MARINE CORP.
GREEN RIDGE	WRYL	CENTRAL GULF LINES INC
GREEN SASEBO	3EUT5	INTERNATIONAL SHIPPING CO INC
HANEI SKY	3EZM3	CASCADE SHIPPING CO
HANEI SUN	3EXR3	CASCADE SHIPPING CO
HANJIN SEATTLE	D9SF	HANJIN CONTAINER LINE LTD
HANJIN YOKOHAMA	3ESM4	HANJIN CONTAINER LINE LTD
HENRY STEINBRENNER	WB4501	KINSMAN LINES, INC.
HONESTA	3ESG6	MATSON NAVIGATION CO
HUAL TRANSPORTER	3EOC4	COMPASS MARINE (U.S.A.)
JOHANNA OLDENDORFF	ZDBE9	OCEANS INTERNATIONAL
JSS MEONIA	OXON	EAC TRANSPORT AGENCIES
KEE LUNG	BHFN	GENERAL STEAMSHIP CORP
LIRCAY	ELEV8	CHILEAN LINE, INC
LLOYD ARGENTINA	PPVN	CAPTAIN RENATO P.S. CARNEIRO
MALINI	ZDA07	GREAT EASTERN SHIPPING CO. LTD
MARIT MAERSK	OZFC2	MAERSK LINES
MING GALAXY	BLHW	SOLAR INTERNATIONAL SHIPPING
MING PLENTY	BLIK	SOLAR INTERNATIONAL SHIPPING
MING UNIVERSE	BLHZ	SOLAR INTERNATIONAL SHIPPING
NOSAC RANGER	WRYG	BARBER WILHELMSEN AGENCIES
NOSAC TASCO	3ENH5	BARBER WILHELMSEN AGENCY
OCEAN CHALLENGER	WSDB	GLENEAGLE SHIP MANAGEMENT
PERSEVERANCE	S6HT	WALLEM SHIPMANAGEMENT LTD.
PRESIDENT JACKSON	WRYC	AMERICAN PRESIDENT LINES
PRESIDENT POLK	WYRD	AMERICAN PRESIDENT LINES
PRINCESS BETTY	XYEH	COMPASS MARINE (U.S.A.)
ROSETTA	3EUX6	BARBER SHIP MGMT. LTD.
S/L DISCOVERY	WZJO	
SANKO HUMANITY	3FVW2	CASCADE SHIPPING CO
SEA WEALTH	3ELP6	INTERNATIONAL SHIPPING CO INC
SEAHAWK	3EXQ4	INTERNATIONAL SHIPPING CO INC
STAR EVVIVA	LAHE2	PALMETTO SHIPPING CO
STAR FLORIDA	ELEI7	STAR SHIPPING INC
SUN MASTER	3EIX4	FRITZ MARITIME AGENCY
TERESA O.	DUVA	COMPASS MARINE (U.S.A.)
THE PERFORMER	C6CX5	OCEAN SYSTEMS ENGINEERING
URTE	DPUP	HAWAII-PACIFIC MARITIME, INC
USNS ALGOL	NAMW	COMMANDING OFFICER
USNS MERCURY	NEMX	MILITARY SEA LIFT COMMAND
USNS NAKRAGANSETT	NVBK	MSC PAC
WESTWOOD CLEO	C6CJ5	NORTON LILLY & CO INC.
YANKEE CLIPPER	DLEI	BOSTON OVERSEAS INC

BATHYTHERMAL/TESAC OBSERVATIONS

Ships are reminded to use the correct format for Bathythermal/Tesac Observations. Bathys/Tesac should start with JJXX and end with the Call Sign.

EXAMPLE: **JJXX** 20106 0312/
74519 05528 88888 00098 26097
28098 29094 33069 36044 37026
38014 39009 41004 46503 48505
59508 84512 9901 36512 37512
38512 39355 46355 0000
VCTB

Julie L. Houston
National Weather Service
Silver Spring, MD 20910

METEOROLOGICAL SHIP SURFACE OBSERVATIONS

Ships are reminded to use the correct format for Meteorological Surface Observations. Meteorological Observations should begin with the Ship's call sign.

INMARSAT FORMAT EXAMPLE

WLXX 29003 99131 70808 41998 60909 10250 2021/ 40110 52003 71611 85264 22234 00261 31100 40803 ....

COASTAL RADIO STATIONS EXAMPLE

WLXX 2900399131 7080841998 6090910250 2021/40110 5200371611 8526422234 0026120201 3110040803

INMARSAT Reports Procedure

INMARSAT Equipped ships may transmit weather messages using the following procedures after the message is composed off-line:

1. Select U.S. Coast Earth Station Identification CODE 01.
2. Select routine priority.
3. Select duplex telex channel.
4. Initiate the call.
   Upon receipt of GA (Go Ahead).
5. Select dial code for meteorological reports, 41, followed by the end of selection signal, +.
   41+ (or 00 23 6715250+)
6. Upon receipt of our answerback, NWS OBS MHTS, transmit the ships call sign and the weather message only. Do not send any other preamble.

CHANGES

Please send any changes to the publication **Selected Worldwide Marine Weather Broadcasts** to the following address:

National Weather Service
International Telecommunications
Section W/0S0151 ROOM 419
8060 13th Street
Silver Spring, MD 20910

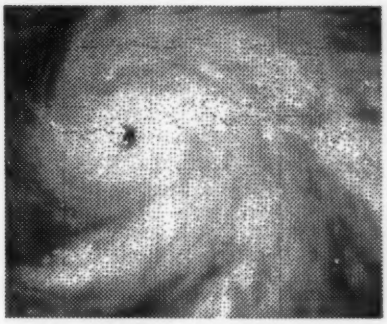
AVAILABLE

Information concerning Coast Earth Station ID codes and Telex and Telephone Country Codes can be found in the INMARSAT Users Guide. The Users Guide is available at the address below:

COMSAT Maritime Services
950 L'Enfant Plaza, S.W.
Washington, DC 20024

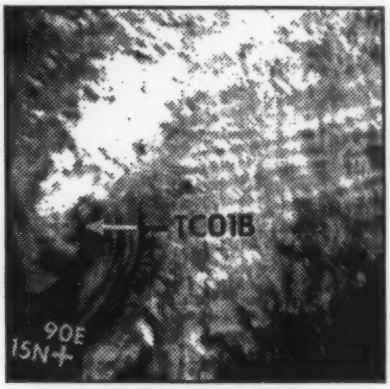
ATTN: James Jansco

Eight significant tropical cyclones developed in the North Indian Ocean during 1987. That set a new all–time record and surpassed the previous high of seven systems in 1979. This was in sharp contrast with 1986 when only three significant tropical cyclones were observed. The long–term mean is about four per year. These eight were all of tropical storm intensity and developed during the Spring and Fall transition periods. These are the seasons between the Northeast and Southwest Monsoons. This summary was part of the Joint Typhoon Warning Center's Annual Typhoon Report, 1987. We are grateful for the assistance they provide in addition to the valuable forecasts they provide to shipping in the tropics. Unless otherwise stated all times are UTC and all miles are nautical.

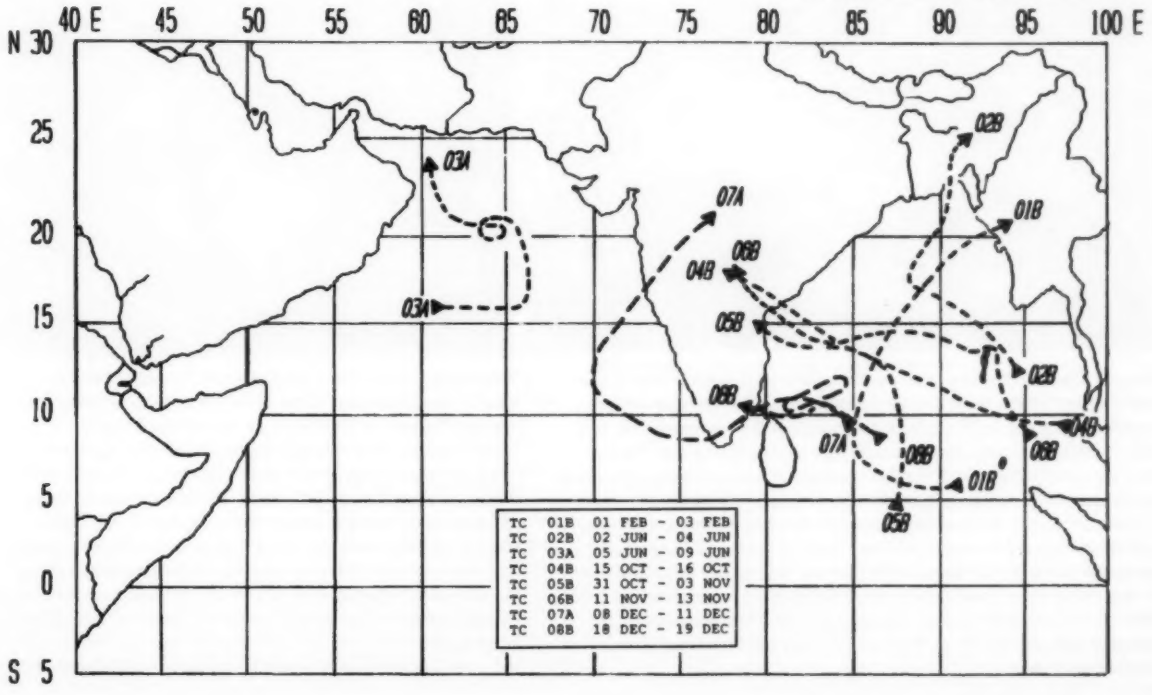


North Indian Ocean Tropical Cyclones, 1987

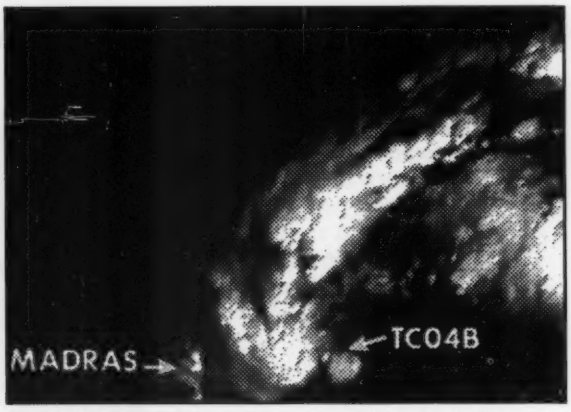
(from the *Annual Typhoon Report, 1987* by the Joint Typhoon Warning Center, Guam)



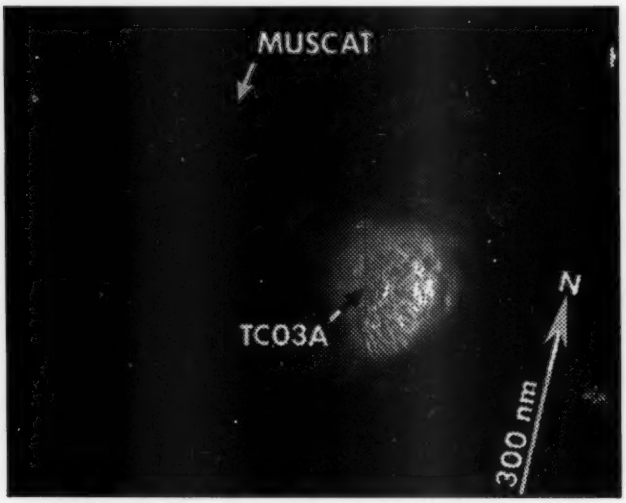
Tropical Cyclone 01B was the first storm to form in the Bay of Bengal during 1987. It was first spotted some 500 miles east of Sri Lanka on January 29th. Within the next 24 hours, the organization and convection steadily increased. The first warning was issued at 0000 February 1st, with the appearance of a central dense overcast. The system tracked northeastward. It peaked at 0600 on the 2d when winds reached 55 knots. A partially exposed low–level center became apparent at 0000 on the 3d, 6 hours before this photo. At 1200 the JTWC issued its final warning as the storm began to weaken.



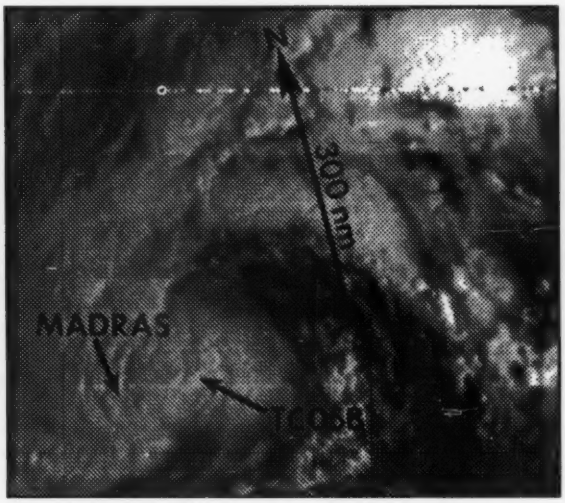
Tropical Cyclone 02B formed in the Bay of Bengal, about 220 miles southwest of Rangoon, Burma on about the 1st of June. The initial warning was issued at 0600 on the 2d as development continued. The storm moved northwestward, then recurved toward the northeast. The photo was shot at 0421 on the 3d. Tropical cyclone 02B reached its maximum intensity on the 4th at about 0600, when winds peaked at 55 knots. This intensity was maintained until the system made landfall over Bangladesh at 1200 on the 4th. Rapid dissipation followed and no reports of damage or loss of life were received.



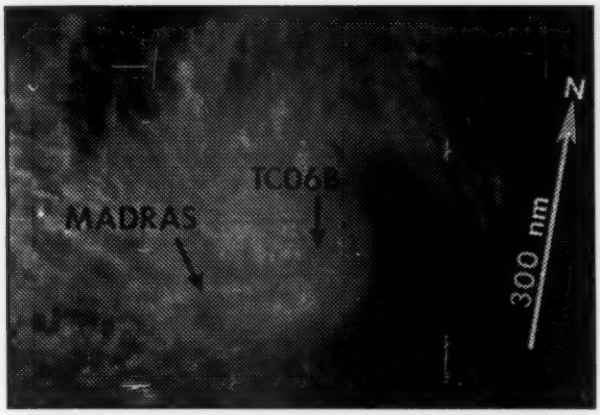
Tropical Cyclone 04B began as a monsoon depression in the Andaman Sea on the 12th of October and tracked toward the west northwest. The following day the cloud system had separated from the general monsoonal cloudiness. The first warning, which indicated landfall within the next 12 to 24 hours, was also designated the final warning. However the forecast proved to be optimistic. At 1800 on the 15th, Tropical Cyclone 04B peaked at 45 knots and a second warning was issued. The storm was still over water. By early on the 16th it moved inland and weakened.



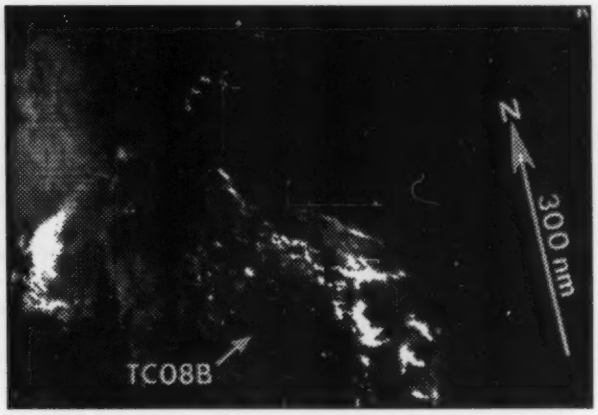
Tropical Cyclone 03A began on the 4th of June as a monsoon depression with the supporting convection displaced from the low-level circulation center. Throughout its life, a brisk southwesterly flow dominated the low levels with an overlying tropical easterly jet in the upper levels. The low pressure center developed 250 miles southeast of central Oman and moved slowly eastward. An expanded radius of winds over 30 knots in the southern semicircle resulted from the interaction between the tropical cyclone and the already brisk monsoonal flow. Tropical Cyclone 03A reached a maximum intensity of 50 knots at 0000 on the 6th, shortly before it abruptly changed its track toward the north. This intensity was maintained until 0000 on the 8th when the track became westerly. The final warning was issued at 1200 on the 9th, as the system rapidly weakened due to increased vertical wind shear.



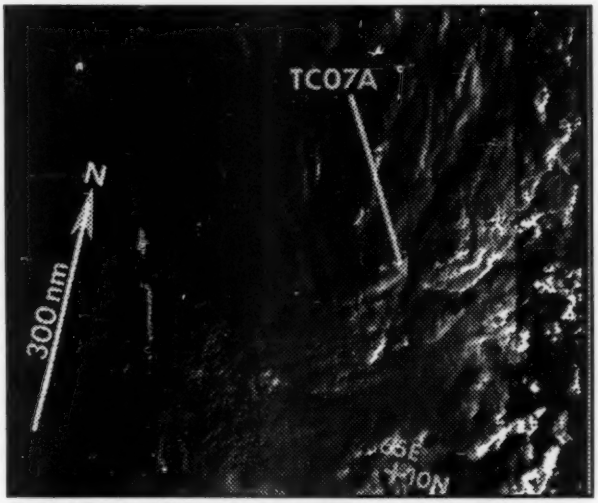
Tropical Cyclone 05B was spawned in a monsoon trough over the Bay of Bengal midway between Sri Lanka and norhtern Sumatra in late October. A Tropical Cyclone Formation Alert was sent out at 1557 on the 30th. The first warning was issued at 0000 on the 31st. Tropical Cyclone 05B moved toward the north. It soon assumed a northwestward track and slowed in forward speed. The peak intensity was reached at 1200 on the 1st of November. This was maintained until the system was close inshore as evidenced by the well-defined convective cloud band on the satellite image above, which was taken at 0221 on the 2d. The final warning was issued at 0600 on the 3d as Tropical Cyclone 05B was dissipating over land.



Tropical Cyclone 06B became evident on satellite imagery on the 8th of November as a weakly organized area of convection in the northern Andaman Sea. On the 10th sparse synoptic data implied a closed, low–level cyclonic circulation. The first warning was issued at 1800 on the 11th. The storm reached a peak intensity of 50 knots at 1800 on the 12th, which is the time of the above photo. The storm moved northwestward and 4 hours later it made landfall. Tropical Cyclone 06B rapidly weakened while it moved into the Eastern Ghats mountains along the coast.



Tropical Cyclone 08B was the record–setting eighth system to develop in the North Indian Ocean in 1987. It began as a rapidly organizing tropical disturbance 375 miles east of Sri Lanka on the 16th. The first warning was issued on the 17th at 1400, when it developed a central dense overcast and wind speeds reached 30 knots. The system slowed dramatically on the 18th and the following day it changed course toward the northeast. Strong vertical shear seemed to spell the end for this storm but its remnants reorganized. On the 20th maximum winds reached 35 knots. However the following day it weakened.



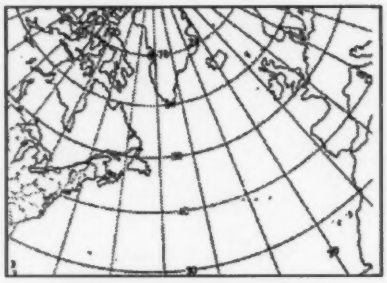
Tropical Cyclone 07A was the first significant tropical cyclone in the Arabian Sea during the month of December since 1980. It also marked the first time since 1979 that seven significant tropical cyclones have occurred in the North Indian Ocean. This storm initially developed as an exposed low–level circulation on December 2d. It intensified slowly, generating 30–knots winds before making landfall on the southeast coast of India at 1900 on the 4th, some 150 miles south of Madras. Synoptic data indicated that the system maintained its identity as it tracked across the southern tip of India. The first warning was issued at 1200 on the 8th and a maximum intensity of 45 knots was reached at 1200 on the 10th, prior to a northward recurvature. The cyclone headed toward the west coast of India on the 11th, but it weakened just before landfall some 90 miles south of Bombay at 0000 on the 12th.

North Indian Ocean

1987 Significant Tropical Cyclones

Tropical Cyclone	Period of Warning	Calendar Days of Warning	Number of Warnings Issued	Maximum Surface Winds-kn(m/s)	Estimated MSLP-MB
TC 01B	01-FEB - 03 FEB	3	11	55 (28)	984
TC 02B	02 JUN - 05 JUN	4	12	55 (28)	983
TC 03A	05 JUN - 09 JUN	5	18	50 (26)	987
TC 04B	15 OCT - 16 OCT	2	3	45 (23)	991
TC 05B	31 OCT - 03 NOV	4	14	40 (21)	984
TC 06B	11 NOV - 13 NOV	3	6	50 (26)	987
TC 07A	08 DEC - 11 DEC	4	14	45 (23)	991
TC 08B	18 DEC - 19 DEC	2	5	35 (18)	997
	1987 Totals:	26*	83		

*Overlapping days are counted only once in sum.



North Atlantic Weather Log July, August and September 1988

July— Three of the sweetest words a weatherwise mariner can hear — Azores-Bermuda High. It was in place and slightly stronger than normal except for its northeastward extension (fig 1). This extension, which usually assures Europe of good summer weather, was displaced by an out-of-season 1004-mb Icelandic Low, centered over Scotland, and influencing weather from the eastern North Atlantic, to the Norwegian and North Seas. Anomalies ranged up to -9mb. The Great Lakes were on the northwestern perimeter of the Azores-Bermuda High while its eastward extension covered about one-half of the Mediterranean Sea. The upper atmosphere, at 700 mb, was a reflection of surface features. This resulted in a nearly zonal flow north of 40°N and a weak flow to the south. A storm off New York would ideally end up over Spain under this pattern.

On This Date — July 29, 1905 — Heavy rain in southwestern Connecticut caused a dam to break. The resulting flood caused $250,000 damage at Bridgeport. As much as 11 in fell prior to the flood.

Extratropical Cyclones — If you had to guess where all the action was this month, it wouldn't be too hard by looking at the mean pressure chart. The 1004-mb Icelandic Low is a direct reflection of this action. While summer activity is usually not as dramatic as it is in other seasons, nonetheless, a 980-mb Low bucking against the Azores-Bermuda High can create a stiff pressure gradient and gale force winds.

In addition coastal thunderstorms added to the near-shore problems where traffic is often congested and navigation is critical. This month's coastal activity was reported on both sides of the Atlantic. On the 7th, Brownsville, TX suffered a heavy thunderstorm resulting in the collapse of a department store roof and the deaths of 14 people. On the 28th, in the Gulf of Riga, a sudden storm scattered 31 vessels competing in the Latvian sailing regatta. Some returned to port immediately. However of the 28 that remained out five vessels washed ashore and one, with a crew of four, was missing.

As the month opened this 988-mb Low was positioned just east of Ireland, near 43°N, 5°W. The system moved slowly northeastward. On the 3d the center split. One portion of the storm moved into the North Sea and stalled for several days while the other headed toward the Barents Seas. The southern system, fed by atmospheric waves, hung around for another week. While not generating gales, it continued to bring unstable weather to Great Britain and the surrounding seas.

❶ Another contribution to the Icelandic Low was made by this system, which formed along a front southwest of Iceland on the 8th. At 1200 on the 9th the ***Anatoly Vassilev***, just to the southwest of the storm's center, reported 48-kn westerlies in 18-ft seas. At this time the 989-mb storm was getting organized and heading northeastward. The UEJY, the following day, ran into a 41-kn westerly in 16-ft seas, more than 400 mi southwest of the center. By 1200 on the 10th the 988-mb storm began to turn eastward as it crossed the 60th parallel, near 15°W. From the LFAW (61°N, 3°E), at 1800 on the 10th, came a report of 40-kn south southeasterlies as the system slowed just southeast of Iceland. The gale reports came mostly from southeast of the center by vessels such as the ***Iolair*** and ***Champs Elysees***. By late on the 11th the Low became part of a complex multicentered system that stretched from off Great Britain to the

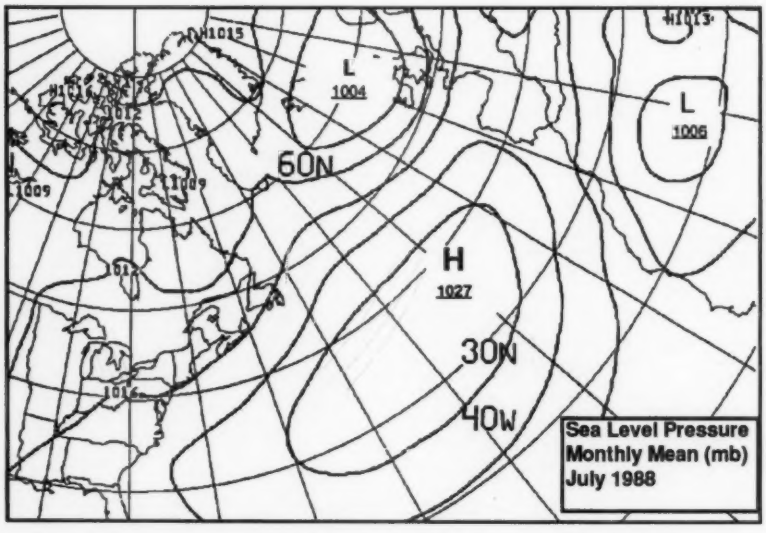


Figure 1.—The Azores-Bermuda High is the outstanding feature but the Icelandic Low figured in the weather picture over the shipping lanes.

Figure 2.— Early on the 16th a satellite shot shows the circulation to the south of Iceland.

Norwegian Sea. It remained a weather–producer for several more days.

❷ This system originated off Labrador as a wave along a front. By the 15th, at 1200, it was a potent 990–mb storm southwest of Iceland. Its pressure gradient was being squeezed by a 1031–mb High to the southeast. Six hr earlier ***OSV C*** (53°N, 36°W) ran into a 47–kn west northwest wind in 10–ft seas. Out ahead of the storm the ***Budowlany*** reported 47–kn southwesterlies at 1200. Six hr later the ***Tour Prignac*** and the ***Stena Britannica*** came in with 40–to 43–kn winds. By 0000 on the 16th, central pressure was down to 984 mb as the system approached Iceland (fig 2). Nearly 500 mi to the south southwest, the ***Budowlany*** was battered by 48–kn winds, from the south southwest, at 0000 on the 10th. Six hr later they increased to 52–kn from the west. At the same time the ***Ikan Pari*** (56°N, 25°W) was nailed by 40–kn west northwesterlies. Later in the day the storm began to weaken significantly.

❸ The month closed similar to the way it opened— with a storm off Great Britain. This powerful storm resulted from a merger of two systems from the southwest. Both were fairly potent on the 24th, but the following day they combined to produce a large 977–mb Low north of Scotland. At 1800 an occluded front in the North Sea became a cold front in the English Channel, which swung out into the central Atlantic; this was part of the overall system. The Faroe Islands, near the center of the storm, reported a 978.7–mb pressure. Winds of 30 kn were common throughout Great Britain and the North Sea. The center drifted north northwestward as its influence extended into the Denmark St on the 27th. The cold front was moving across the western Mediterranean. A couple of weaker storms added a further boost on the 29th. The northern part of the North Sea was raked by 40–to 50–kn winds. At 1200 the VSBT (57°N, 5°E) came in with a 50–kn southwesterly in 16–ft swells and a 991–mb pressure. Other reports of gales came in from the VSBR, ***Shetland Service***, ***Maersk Dispatcher*** and ***Iolair*** among others. This continued throughout the day.

Tropical Cyclones— There were no tropical storms or hurricanes in the North Atlantic in July. This is not unusual. Even though the normal hurricane season extends from June through November, July averages about one hurricane every 4 or 5 yr and one tropical storm or hurricane about once every 2 yr. According to the National Hurricane Center, the Atlantic was characterized by active easterly disturbances and deep easterly flow during most of July. This is usually a favorable pattern for tropical cyclone formation over the Atlantic. However, there were no tropical depressions, tropical storms or hurricanes during the month of July. Several factors may have contributed to the lack of tropical cyclone development. The tropical Atlantic water and atmospheric temperatures were still not warm enough to produce organized convection, over an extended period, in the tropical waves. Also surface pressures were slightly above normal through the western Atlantic. A large–scale feature that frequently limited development of waves approaching the Lesser Antilles, was a nearly stationary 200–mb trough, or closed low, northeast of the Antilles. This pattern produced shearing conditions over the tropical waves. Over the Caribbean Sea and Gulf of Mexico rapidly changing upper–level patterns prevented the formation of an organized, enduring outflow, which the often slowly–developing systems of this area require to evolve from frontal troughs and upper–level lows.

Casualties— Although no reports of weather related casualties were received, the threat of high winds caused a mishap. A North Sea drilling rig had been damaged in June when hit by the ***Irving Forest***. The ***Glomar Labrador 1*** was evacuated on the 15th following fears that high winds could capsize the disabled platform. This event was followed later in the day by 16 oil workers being plunged into the sea off Norway when their helicopter was forced down by a mechanical problem. The drilling crew was picked up by another rescue helicopter with no injuries reported.

August— The Icelandic Low was closer in appearance to October than August. However, the subtropical High was its dominant self, covering most of the North Atlantic (fig 3). The result was a tighter than normal pressure gradient over the northern shipping lanes, a –8 mb anomaly center just south of Iceland and a –5 mb center over the Gulf of Finland. This was reflected in the steering current at 700mb with a strong nearly zonal flow between 40°N and 50°N.

On This Date — August 9, 1882 — A snowstorm was reported by a ship on Lake Michigan. A thick cloud reportedly burst on the decks covering them with snow and slush 6 in deep. Snow showers were also observed at several shore points.

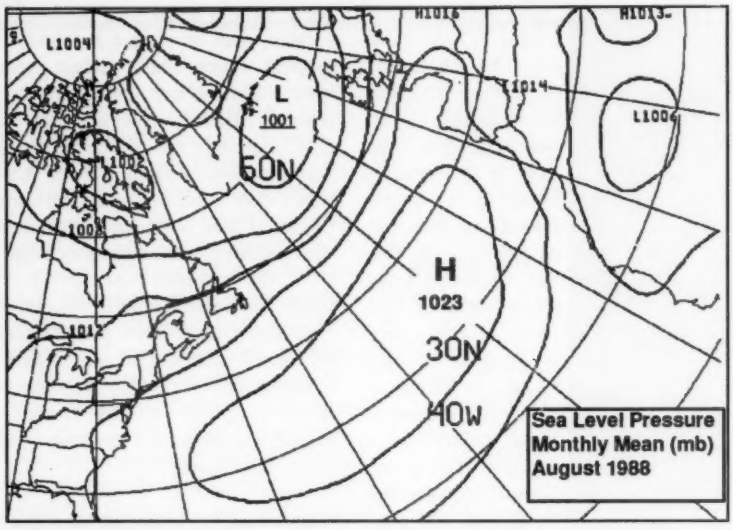


Figure 3.— October in August was the theme for this month's mean pressure picture.

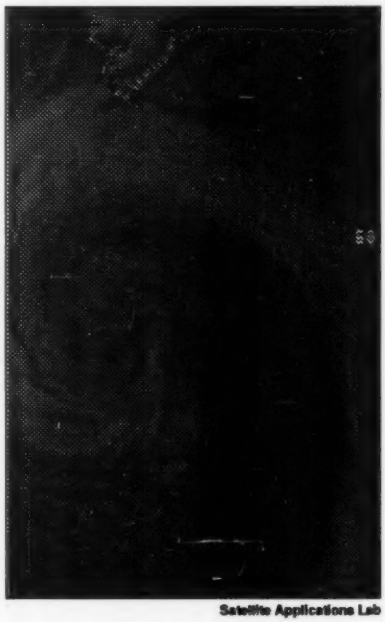
Extratropical Cyclones — As would be expected there was a cluster of storms south of Iceland that made up the out–of–season Icelandic low.

On the 5th of August a cold front pushing into warm and humid air over the lower Great Lakes triggered a line of severe thunderstorms. These storms generated damaging winds and heavy rainfall. A thunderstorm near Hastings, MI had winds clocked at 70 kn, while another in Shelbyville produced gusts to 59 kn. Docks were torn up, trees were knocked down and flooding closed roads; a half inch of rain fell in less than 15 min at Flint, MI. Water was reported up to a foot deep near Indianapolis, IN. In addition, numerous fires were reported, due to lightning strikes.

❶ This storm began on the 14th just southeast of Calgary, Alberta in Canada. It was just a weak atmospheric wave along a large cold front, a long way from the Atlantic shipping lanes. It moved through the northern U.S. for a few days and then, on the 17th, headed southeastward. It wasn't until the 21st that the system got off the southeast coast of the U.S. near Wilmington, NC. Even at this time the circulation was nothing to write home about. At 1800 a vessel near 42°N, 57°W encountered a 40–kn south southwesterly in a violent rain shower, from the wave that preceded this wave. Finally, on the 23d, this system developed its own circulation and became dominant. At 1200 on the 24th, the PELT hit 50–kn northerlies, near 40°N, 49°W, and seas were estimated at 12 ft. The storm was heading toward the northeast. After crossing the 55th parallel, near 20°W, it really began to deepen. The 992–mb center at 1200 on the 26th fell to 976 mb in 24hr. Winds of 40 to 50 kn, at 1200, came in from the ***Norna***, ***Vigilant*** and ***Charlotte Bastian*** ; they were about 250 mi southeast of the center and just ahead of the cold front. Their pressures ranged from 981 mb to 991 mb in swells of 10 to 23 ft. The Low moved northward but continued to pound the waters north of Scotland. Additional reports came in from the P3PE, ***Nuka Ittuk*** and the LFAW. At 0300, on the 28th, the ***Eyrarfoss*** hit 44–kn southerlies, with a 986–mb pressure, some 60 mi east of the center. To the north of the center, between Jan Mayen and the coast of Greenland, the WVFQ and the OVEL ran into northerlies at 45 and 48 kn respectively. The storm remained potent through the end of the month as the center meandered toward Iceland.

❷ **Monster of the Month**— It's rare to have a monster in August, but this storm earned the title. While the previous system was just a weak wave over North

Dakota, on the 16th, this system exploded on to the scene. Its origins can be traced back to the Bay of Fundy on the 14th. It began as a wave along the same front as the previous system. By late in the day it was a 996–mb Low moving due eastward— nothing spectacular. To the northeast was another center that was weakening. The following day there were definite signs that the circulation was becoming more organized, but nothing in the way of ship reports to indicate real trouble. At 1200 on the 15th, a 985–mb center was located near 44°N, 38°W. Some 24 hr later, pressure was down to 959 mb and new center was positioned near 54°N, 36°W. At 0600 on the 16th, near 47°N, 31°W, the PELU indicated 40–kn west southwesterlies in 20–ft seas. The indication is that a great deal of the deepening took place between 0600 and



Satellite Applications Lab

Figure 4.— This August monster is located south of Greenland on the 16th.

1200 on the 16th (fig 4). At 1200 the C4PA ran into 60–kn northwesterlies near 49°N, 42°W while the ***Heinrich Heine*** hit 56–kn southerlies ahead of the cold front, well to the southeast of the center. Some 200 mi to the northwest the ***Bakafoss*** encountered 44–kn northerlies. Winds during the day ranged from 40 to 50 kn. At 0000 on the 17th, the VPHH hit 53–kn northwest winds in 30–ft seas some 250 mi southwest, of the 968–mb center. Winds were being reported in the 45– to 55–kn range as the Low squeezed the pressure gradient between a 1024–mb High to the southeast and another Low over Finland. The system pushed eastward on the 18th as central pressure rose to 984 mb by 1200— still a potent storm. It moved to just east of Scotland on the 19th. At 1200 the ***Champs Elysees*** in the English Channel picked up a 40–kn southwesterly in 13–ft seas. Meanwhile a new center was developing to the north and gradually took over.

Tropical Cyclones— A weak trough of low pressure formed off the South Carolina coast on August 4th and became better organized as it moved northeastward around 15 kn. Although it was classified by satellite on the 5th, the system was not designated the second tropical depression of the 1988 hurricane season until the afternoon of the 6th when it was off the Virginia Capes.

The approach of a weak frontal trough from the Ohio Valley began to accelerate the northeastward motion and also enhanced the upper level outflow during the night of the 6th. It was designated tropical storm **Alberto** on the 7th, south of Nantucket. Alberto was moving toward the northeast around 25 kn. It reached the west coast of Nova Scotia, on the evening of the 7th, and become extratropical, on the 8th, over the cold waters of the Gulf of St Lawrence. The system dissipated north of Newfoundland that afternoon.

The maximum sustained winds were 35 kn on the 7th. On that day a NOAA buoy, southeast of Nantucket, reported easterly winds of 15 kn and a pressure of 1011.2 mb at 0900, and at 1200, a northwest wind of 30 kn and a pressure of 1003.9 mb.

The rapid northeastward movement of Alberto, over the cold waters off New England, limited convection so that it gradually weakened after passing Nantucket. The storm skirted along the west coast of Nova Scotia but caused no significant damage there or elsewhere along its track.

The tropical depression which was to become Tropical Storm **Beryl**, formed over southeastern Louisiana, on the evening of August 7th. After drifting southeastward over the Mississippi Sound, with major portions of the system remaining over land, the depression strengthened to a storm. It buffeted the immediate coastal sections and offshore oil rigs with minimal tropical storm–force winds. Beryl made a clockwise loop and headed northwestward by the evening of the 8th. It passed over the New Orleans area shortly before daybreak on the 9th. The short–lived tropical storm was downgraded to a depression by that evening, and the remnants became a major rain producer over northeast Texas by the 11th.

Tropical storm Beryl produced minimal tropical storm–force winds over the open waters of the Gulf and tropical storm–force gusts over the coastal sections of southeast Louisiana, Mississippi and Alabama. A maximum sustained wind of 40 kn at Gulfport was the strongest reported from a land station, while the ***Primula*** and the offshore oil rig P21 (MP73) each observed a maximum sustained wind of 46 kn.

Heaviest rainfall from the system occurred over eastern Texas on the 11th as the remnants of Beryl dumped up to 12.5 in of rain during the day. Storm totals of over 11 in were reported at Dauphin Island, AL, while close to 10 in fell at Foley, AL, and Bay St. Louis, MS. Elsewhere, storm totals of 3 to 5 in were received over the southern portions of Louisiana, Mississippi and Alabama.

Tides, in excess of 5 ft, were observed along the east coast of extreme southeastern Louisiana. Onshore winds pushed tides to more than 4 ft above normal along the Mississippi coast, while tides of only 1 to 2 feet above normal were observed along the coastal sections of Alabama and the extreme western

Figure 5.— Beryl on the 9th of August, at 1330 is already inland over Louisiana.

Florida Panhandle.

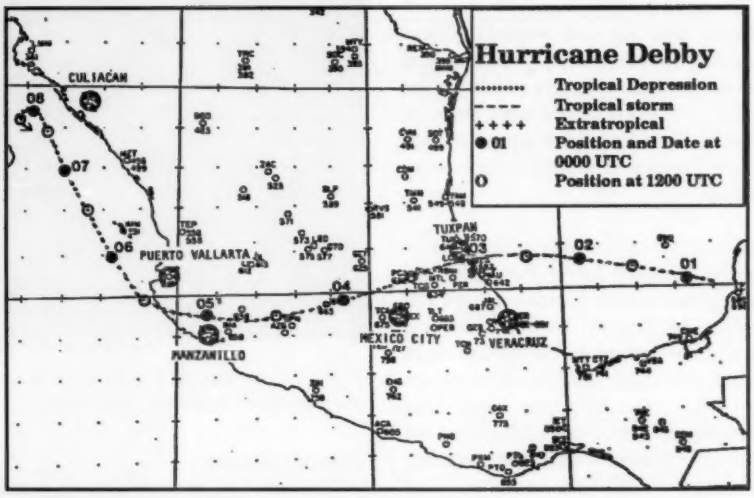
The only known death directly caused by the storm occurred in Mobile Bay, when a 15–yr old boy drowned due to an overturned shrimp boat. The boy's father was rescued by the Coast Guard after spending 24 hr in the water.

Overall damage from the tropical storm was light. Initial estimates range from $2 to $4 million. Most of the damage occurred along the immediate coast and can be attributed to erosion and flooding due to surge and wave action.

Chris was first detected as a tropical wave, near the west coast of Africa, on the 15th of August. It became a tropical depression on the 21st midway between Africa and the Lesser Antilles, when a low–level cloud circulation was identified on satellite imagery. Chris remained a depression for 7 days as it moved from the tropical Atlantic across portions of the Lesser and Greater Antilles and over the Bahamas. It became a tropical storm for only 12 hr, during which time it moved inland near Savannah, GA.

On the 28th, reconnaissance aircraft located a low–level circulation center, at 0600, just east of Melbourne, FL and a ship, located about 50 mi northeast of the center, reported 40–kn sustained winds; the system was upgraded to Tropical Storm Chris on this basis.

The center of Chris made landfall, at 1500, on the 28th near Savannah. The highest observed sustained wind speed was 37 kn at the Savannah Light Tower, with an anemometer elevation of 70 ft. Storm tides ranged up to 1.5 ft above



normal. Storm rainfall totals near the coast were less than 3 in.

Chris weakened to a depression over South Carolina and then merged with a front. The surface low pressure system was tracked across the northeastern U.S. and over to Nova Scotia on the 30th. Inland rainfall amounts ranged from 3 to 5 in a swath from South Carolina through Pennsylvania and into Vermont. Strong thunderstorms also accompanied the low center. One death and one injury resulted from a tornado that destroyed a number of mobile homes in Clarendon County, SC. Otherwise, in general, wind damage was minor. The total U.S. dollar damage for this storm is estimated at $.5 million. While near Puerto Rico on the 24th, the depression dumped 4.5 in of rain on the island and three deaths were attributed to the weather.

Debby, the season's first hurricane, was also one of the shortest–lived on record. It was a hurricane for only 6 hr before moving ashore just south of Tuxpan, Mexico. The last hurricane to strike that portion of the Gulf Coast of Mexico was Abby in 1956, another short–lived hurricane. In 1955, three hurricanes — Gladys, Hilda, Janet — struck that general area.

A rather strong tropical wave moved off the northwest coast of Africa on the 15th of August. As the system moved westward across the tropical Atlantic, a detached area of convection in the northern portion of the wave became Tropical Depression Seven east of the Lesser Antilles. This system continued moving west northwestward and later became Storm Chris near the east coast of Florida. Meanwhile, the southern portion of the tropical wave continued moving westward, across the Caribbean Sea as a disorganized area of showers. Some indications of cloud banding were evident during the night of the 29th. A low–level center formed over the Yucatan Peninsula on the 30th. This low–level center emerged over the eastern Bay of Campeche on the 31st and, based on satellite imagery, it is estimated that Tropical Depression Eight formed at about 1800.

Cloud banding became better organized and the outflow pattern improved as the center moved in a general west northwesterly direction. Substantial development took place on the next day and the system reached tropical storm strength at about 0600 on the 2d.

Tropical Storm Debby continued moving toward the Tuxpan, Mexico area. A reconnaissance report filed at 1701 indicated 80–kn winds at the 1500–ft flight level with 70 kn estimated at the surface. Based on that observation, Debby was upgraded to a hurricane. Since the reported 15–mi diameter center was only 30 mi from the coast at that time, there were no further reconnaissance reports prior to landfall. Thus, based on satellite imagery, it is estimated that little change in strength occurred prior to the center making landfall, about 20 mi south southeast of Tuxpan, Mexico, near 0000 on the 3d.

Hurricane Debby lost much of its punch over the Sierra Madre Oriental Mountains of Mexico, with the center passing about 45 mi north of Mexico City. The tight center continued moving toward the Pacific coast passing offshore, between Manzanillo and Puerto Vallarta, Mexico, on the 5th. Upon entering the Pacific, the system became Tropical Depression Seventeen–E.

Tropical Depression Seventeen–E remained poorly organized for the next 24 to 48 hr. By the 8th, most of the deep convection had dissipated, there was no outflow at the upper levels, and all that remained was a low–level swirl in the stratocumulus field. It is estimated that the depression dissipated in the Gulf of California, between La Paz, Baja California and Culiacan, Mexico, at 1800 on the 8th.

Three people died when mud slides crushed two houses in Pantla, 16 mi inland, and three storm-related deaths were reported in Poza Rica. Four others died and 16 were injured when a mud slide crushed three houses in the mountain community of Ixtlahuaco, about 100 mi northeast of Mexico City.

On the 27th of August a westward moving tropical wave emerged from the African coast. By the 31st, the wave came under the influence of an upper level low. The most prominent cluster of associated thunderstorms began moving northwestward. The showers and thunderstorms increased in area on the 1st of September due to interaction of the tropical wave with the upper–level low. The convection moved northward, and a 1016-mb surface low was analyzed just east of Bermuda, on the 1800 surface map, on the 2d. By this time the upper low had moved southward and a strong upper–level high became the dominant feature south of the surface low. Satellite imagery showed a poorly defined low-level circulation and the system became a tropical depression at 0000 on the 3rd. Under the influence of southwesterlies aloft, the circulation moved northeastward at 15 to 20 kn. In spite of the southwesterly shear aloft, however, the low level

circulation became defined near the edge of the overcast. Based on satellite imagery, the system was upgraded to Tropical Storm **Ernesto** late on the 3d. Ernesto accelerated northeastward, with its forward motion reaching 35 to 45 kn on the 4th. By the 5th, Ernesto lost tropical characteristics and was absorbed by a large extratropical storm over the North Atlantic.

Tropical storm force winds remained over the open waters of the Atlantic ocean, although the island of Flores in the Azores reported winds of 30 kn as the center of Ernesto passed by over 200 mi to the northwest. There were no reports of casualties or damage related to Ernesto.

Casualties— On the 8th in Tropical Storm Beryl, a 15-yr old boy was missing from a vessel that had capsized near the mouth of Mobile Bay, while the Coast Guard rescued his father. The Coast Guard also rescued six people from a 19-ft vessel forced to take shelter on a small barrier island off the coast of Mississippi.

In Egypt the tour vessel ***Nubia*** sank in the River Nile, on the 10th, during violent winds and rainstorms. Authorities said rescue teams saved 75 people but 25 were listed as missing. Some of the survivors said the accident happened when gusts hit the vessel, spinning her around before she capsized within 13 min. The previous week torrential rains in Sudan and Ethiopia left more than 1 million people homeless. The rains in Khartoum paralyzed normal life and the city was described as nothing but swamps and lakes. The barge WA-3-718 was allegedly damaged, on the 14th, during heavy weather at Leonardo, NJ.

September— Both the Azores-Bermuda High and the Icelandic Low put in stronger-than-normal appearances for this time of the year. The Low had a double center, which resulted in –4 to –5 mb anomalies over Labrador and northern Scandanavia. The High was particularly strong in the eastern North Atlantic and Bay of Biscay. Another interesting feature of the climatic charts in September (fig 6) was an intense (997 mb) low pressure center over the North Pole. This is a spot usually occupied by a weak high pressure area. This resulted in a –16 mb anomaly center in this region. Looking at the storm tracks for both the Atlantic and Pacific, an unusually large number of systems developed or moved north of 70°N this month. The upper air pattern at 700 mb reflected the surface conditions. The result across the Atlantic was steering currents oriented in a west southwest–east northeast direction.

On This Date —September 21, 1938— Fifty years ago the Great Hurricane of 1938 smashed into Long Island and crossed New England, causing great damage and widespread flooding. Winds gusted to 186 mph at Blue Hill, MA. The hurricane was responsible for 600 deaths and $350 million damage. Hardest hit were Connecticut, Rhode Island and Long Island. The "Long Island Express" produced huge waves with its 150–mph winds. The waves smashed against the New England shore with such force that earthquake recording devices on the Pacific Coast clearly showed the shock of each wave.

Extratropical Cyclones— Relatively few potent storms moved across the North Atlantic shipping lanes in September. The northward push of the Azores–Bermuda High kept activity centered around Iceland and in the Gulf of St Lawrence.

On the 22d a cold front trailing out of a Low over the upper Great Lakes generated some intense thunderstorms. Rainfall totaled more than 1.5 in in 30 min at Grand Junction, MI while torrential rain and a 37–kn wind gust were reported in the Battle Creek, MI area.

● The month opened with a viscious storm coming to life southwest of England. By the 2d the 920–mb Low was centered in the Irish Sea and its effects were being felt from the North Sea southward across Spain and France. In Spain at least nine people were reported dead while France suffered 10 causualties. Most of the deaths were due to flash floods triggered by torrential rains from the lst through the 3d. Some areas reported 8 in of rain in 3 hr. More details can be found in the casualty section. At 0000 on the 1st, the ***Paul Buck*** hit 45–kn westerlies near 47°N, 23°W in swells of 21 ft. In the Bay of Biscay the YUES was reporting 40–kn westerlies at 0600 while ships in the English Channel were encountering 40– to 45–kn winds on the 1st. By 1800 gale and storm reports were common. The ***Iolair*** in the North Sea, east of Inverness, was blasted by a 51–kn easterly in 10–ft swells; 6 hr later her winds were 50 kn with a pressure 985 mb and 13–ft swells. Gale to storm force winds continued over the North Sea

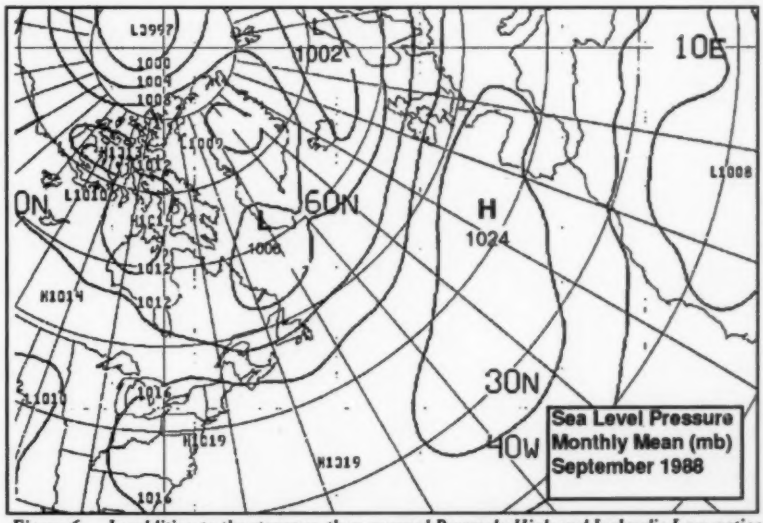


Figure 6.— In addition to the stronger–than–normal Bermuda High and Icelandic Low, notice the low pressure over the North Pole.

throughout the day. On the 2d the storm turned sharply to the northwest and headed for Iceland. It also began to weaken.

❷ This system came to life on the 15th just north of 40°N near 58°W. It started as an atmospheric wave along a front. The following day it had acquired its own circulation and was tracking toward the northeast. At 1800 in the Denmark St the ***Arni Fridriksson*** picked up evidence of this storm system with a north northeast 44–kn wind; By 0000 on the 18th her winds were up to 52 kn with a pressure of 987 mb. A few hours before, the ***Walther Herwig*** had a 52–kn northerly and a 991–mb pressure while battling 23–ft swells. The storm was moving through the Denmark St by the 18th. Winds in the 40– to 45–kn range were common. However by late in the day the storm system began to weaken rapidly.

❸ This baby was first spotted between Lake Winnipeg and Hudson Bay on the 22d. It swung southeastward across James Bay the following day and moved eastward off Labrador by the 25th. It was trailing another system. In fact the leading system was the one responsible for the intense thunderstorms over the upper Great Lakes, which were mentioned earlier. However our trailing storm eventually became the more dominant. By 0000 on the 27th, it had a 986–mb center near 58°N, 20°W. However it wasn't until the 28th that ships began to be affected. The ***Edinburgh Talla*** (58°N, 11°W) at 0000 came in with a 40–kn west northwesterly in 20–ft seas; she repeated this observation 6 hr later. By 1200 the trickle of observations became a stream and by 1800 it was a flood. Vessels such as the FNBM, ***Nedrill 4,*** and ***Petroland L–7*** were hitting winds of 40 to 50 kn in 10– to 20–ft seas. This lasted into the 29th, but was just a forerunner of things to come.

Monster of the Month— (see track on pg 41) While hurricanes do not qualify as monsters of the month — they are all considered monsters— their extratropical remnants do. Former Hurricane Helene was just such a case. Cold air entered its system and by the 30th it was deemed extratropical near 54°N, 33°W. And

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Figure 7 - Ex Hurricane Helene is a large, powerful system as seen here at about 1500 on the 30th, southwest of Iceland.

what a storm it was. At 1200 her central pressure plummeted to 956 mb; a drop of about 24 mb in 6 hr. The circulation dominated the mid North Atlantic. On the 0600 wire a few 40–kn winds appeared to confirm that indeed an extropical cyclone was still breathing. Six hr later all hell broke loose. The ***Jalguiris, Atlantic Conveyor, Ael Europa, Edinburgh Talla, Ravenscraig, CMB Europe, Dusseldorf Express, Victor Bugayev, Kaptanvassos, Enterprise*** and the ***Saiko Maru*** were a few of the vessels that were caught in 40– to 60–kn winds and seas running up to 23 ft. The same story was repeated on the 1800 ticker except that the ***CMB Europa***, near 53°N, 29°W, encountered 70–kn southwesterlies with a 956–mb pressure in 26–ft seas and 36–ft swells; a great observation under what must have been very trying circumstances. Three hr before she was into 50–kn southerlies with a 969–mb pressure. At 1800 on the 30th (fig 7) the central pressure was estimated at 940 mb. What a way to close the month. Of course the storm didn't quit but it did weaken some by the 1st of October. A 953–mb center crossed the 60th parallel, near 25°W, shortly after 0000. Storm force winds continued to come in and seas of 28 to 36 ft could be expected in the storm's southern semicircle. The ***Vis[illegible]akit 3*** (63°N, 27°W) measured a 960–mb pressure while battling 50–kn northeasterlies at 0600. The ***Lagarfoss*** came with a 60–kn reading every 3 hr from 0900 on the 1st until 0000 on the 2d. Her lowest pressure was 969 mb at 1500. Several vessels reported storm force winds. Things finally started to let up on the 3d, as the system moved into the Greenland Sea.

Tropical Cyclones— The first 11 days of September were quite active over the western Gulf of Mexico. Hurricane Debby passed across the Bay of Campeche from the 1st to 2d. Tropical Depression Ten formed and made landfall, over east Texas on the 3d, ahead of a cold front which would serve as the catalyst for **Florence**. The next day, the cloud band accompanying the cold front had left the Texas coast and was entirely over the Gulf of Mexico. On the 5th the convective band moved southeastward and was located from Vera Cruz, Mexico to Tampa, Florida.

On the 5th, the band remained nearly stationary but began to split over the central Gulf as a frontal wave developed over the northern portion and began

moving northeastward. Concurrently, the southern portion began showing signs of tropical organization. The surface pressures associated with the southern portion of the frontal trough were generally low, as indicated by a sampling of ship observations. By the 7th convection had organized a spiral band structure but deep convection was for the most part transitory. A surface circulation appeared to have formed, by 0600, while centered about 180 mi northwest of Merida, Mexico. At 1800 the depression was upgraded to Tropical Storm Florence when Air Force reconnaissance and satellite imagery analysis estimated that the surface wind speed associated with the system reached 35 knots. Florence reached hurricane strength at 1800 on the 9th. The maximum intensity was reached just before landfall, at 2300 on the 9th. Landfall occurred over the western Mississippi Delta 3 hr later. Florence weakened quickly. Maximum sustained winds were reduced below tropical storm strength by 1200 on the 10th. Florence was a hurricane for only about 12 hr. The highest surface wind estimated by Air Force reconnaissance was 85 kn at 2310 on the 9th just before landfall. The highest sustained wind speed near the surface was 70 kn measured on oil platform, MP73 (height unknown), located near 29.3°N, 88.9°W at 0511 on the 10th. The lowest surface pressure reported by Air Force reconnaissance was 982 mb near the time of landfall. An automatic Coast Guard weather station (8R3) located at the Southwest Pass of the Mississippi Delta reported a surface pressure of 987 mb with a calm wind as the eye of the hurricane passed. The closeness of reliable observations within surrounding New Orleans, showed that the center of Florence passed directly over the city and the western portion of Lake Pontchartrain.

Highest storm tides were reported at the same time east of New Orleans, on the Bayou Benvenue, which recorded 7.5 ft above Mean Seal Level (MSL) and on the Industrial Canal where the maximum height reached 6.5 feet above MSL. As the storm passed across the western portion of Lake Pontchartrain, the high water changed rapidly across the Lake from 5.0 ft above MSL at the West End Marina at 0800 to 4.8 ft above MSL near the north end of the Lake Pontchartrain Causeway at 1200 on the 10th.

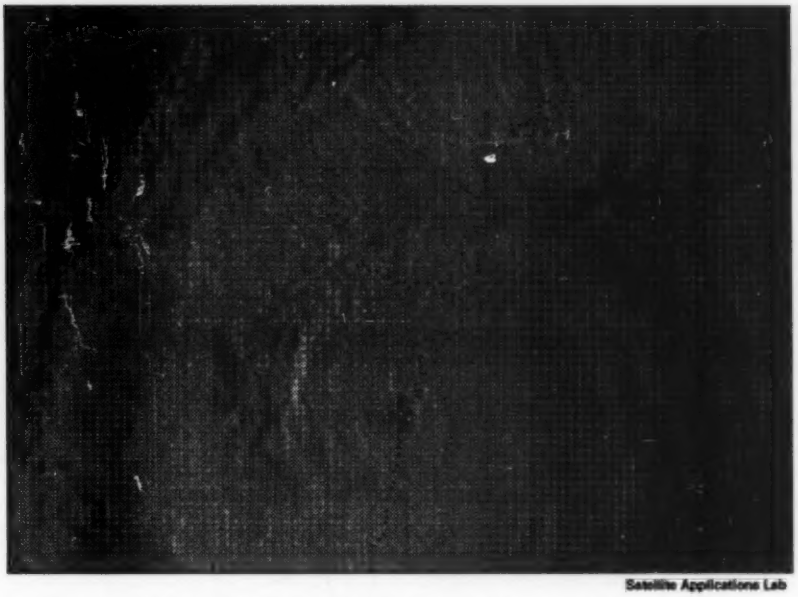

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Figure 8.— The satellite photograph was taken at about 2200 on the 16th of September, as Hurricane Gilbert was making landfall , south of Brownsville, TX.

There were no deaths of injuries attributed to Hurricane Florence in Louisiana, however, one man died in Alabama while attempting to secure a boat in Mobile Bay. Minor storm surge flooding occurred mostly outside the levee system of Plaquemines, St. Bernard, and St Tammany Parishes. Grand Isle suffered extensive beach erosion, losing approximately 40 ft of beach. Light to moderate wind damage was mostly confined to trees throughout the parishes of Orleans, Jefferson, Plaquemines, St Tammany, and St Bernard, causing extensive electrical power outages. Total damage from Hurricane Florence in southeast Louisiana is estimated .o range between $2.0 and $2.5 million dollars. Besides Louisiana, the states of Mississippi and Alabama were affected slightly by Florence. Minor evacuations occurred in each state for residents living in low–lying or coastal areas, but no reports of damage were received. The panhandle of Florida, however, was an exception. The worse flooding in 10 yr occurred when rainfall from Florence was adding to the already swollen rivers of Coldwater and Blackwater in Santa Rosa County. Thirty homes were destroyed and fifty more were damaged along their banks with uninsured losses of $320,000. Damage was estimated at $100,000 due to the tornadoes in Walton County and the waterspout in Bay County.

On the 3d of September a westward moving tropical wave, showing no signs of organization, emerged from the northwest African coast over the open waters of the North Atlantic. During the next several days a broad low pressure area associated with the tropical wave developed over the Atlantic midway between Africa and the Lesser Antilles, with ship reports indicating that the circulation extended nearly to the equator. An organized circulation center was not evident on satellite imagery until the system was approaching the Windward Islands on the 8th. On the 9th the low was classified, by satellite, as the 12th tropical depression of the season, about 400 mi east of Barbados.

The depression moved west northwestward with satellite and reconnaissance reports indicating that it had attained tropical storm strength as it moved over the Lesser Antilles the afternoon of the 9th. Tropical Storm Gilbert rapidly strengthened on the 10th and was classified as a

Wide World

Figure 9.—What is left of a merry–go–round is dragged by the raging waters of the Santa Catarina River near Monterrey, Mexico. This is a normally dry river bed that was the site of soccer and baseball fields and basketball courts. More than 100 persons died when passenger buses were trapped in the rising waters and overturned.

hurricane by that evening. Gilbert continued to strengthen as it brushed the south coast of Hispaniola, then passed directly over the island of Jamaica with sustained winds of 110 kn and a minimum pressure of 960 mb. Following the passage of the center across Jamaica, Gilbert went through a remarkable intensification period with the pressure falling from 960 mb to 888 mb in 24 hr. The 888–mb pressure was observed by a NOAA plane and is the lowest sea level pressure ever recorded in the Western Hemisphere. At the same time the plane measured 160–kn sustained winds at 10,000 ft with a peak wind of 173 kn. The center passed a short distance southeast of Grand Cayman Island, with a wind gust of 136 kn recorded there at 1900.

The center of Gilbert crossed over the northeast portion of the Yucatan Peninsula on the 14th as a category 5 hurricane; the first category 5 hurricane to make landfall in the western hemisphere since Camille in 1969. The hurricane lost strength quite rapidly as the eye moved across the Yucatan Peninsula with the minimum pressure rising to around 950 mb by the time the center emerged over the southwest Gulf of Mexico. Gilbert continued on the same west northwest course across the Gulf and reached the northeast Mexican coast just north of the town of La Pesca around 2200 on the 16th, as a category 3 hurricane (fig 8).

The center of the weakening storm passed south of Monterrey, Mexico on the 17th. It then turned toward the north and moved across western Texas and into Oklahoma as a heavy rain storm on the 18th. It finally merged with a developing frontal low pressure system over Missouri on the 19th.

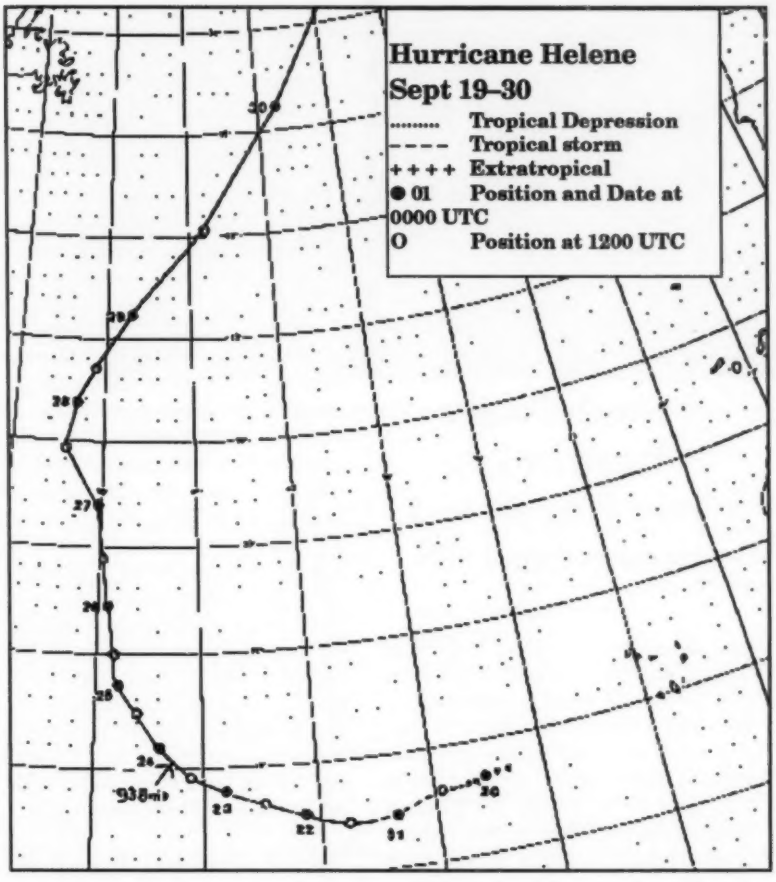
Weather observations in the three landfall areas were difficult to obtain. The only weather office to measure the maximum winds in Gilbert was Kingston, Jamaica, which reported sustained winds of 101 kn with gusts to 122 kn. An unofficial report of 105 kn with gusts to 128 kn was measured by a ham radio operator located 15 mi northeast of Kingston. There were no official reports of maximum winds near the center in the landfall areas of Mexico. Along the lower Texas coast winds in the Brownsville area gusted to 58 kn. Gusts to 72 kn were reported near Port Isabel by an observer with a truck–mounted anemometer. A gust of 53 kn was observed by the National Weather Service in Corpus Christi. Likewise no minimum pressure readings in the eye of Gilbert were reported as it moved ashore in Mexico. The weather office in Kingston had a minimum pressure of 964.8 mb in the eye. The pressure was estimated to be near 900 mb when the eye of Gilbert moved over Cozumel, Mexico.

Torrential rains accompanied the hurricane with between 5 and 10 in falling over the coastal sections and much greater amounts in the mountainous areas of Jamaica and Mexico. Massive flooding in the Monterrey, Mexico area caused many of the deaths attributed to Gilbert (fig 9). Rains of 2 to 4 in fell across south Texas with local amounts of more than 8 in observed near Aransas Pass.

A 15–to 20–ft storm surge most likely occurred along the immediate coast near and just to the north of where the center moved inland, over the northeast Yucatan Peninsula. A surge of 8 to 13 ft struck the coast of eastern Mexico near and just to the north of landfall. There was a report of a 9–ft surge topped by 30–ft waves on the northeast coast of Jamaica. Tides of 3 to 5 ft above normal were reported along the Texas coast. A number of low–lying roads were under water. There was considerable beach erosion on Padre Island.

At least 29 tornadoes were observed across south Texas with most of the damage occurring in the San Antonio area. This total included ten in the Lower Rio Grande Valley, five around Corpus Christi and at least a half a dozen in the San Antonio area. The greatest destruction there occurred at the Air Logistics Center on Kelly Air Force Base, where a number of large storage hangers were destroyed. Damage was estimated near $22 million. A tornado in Del Rio destroyed 15 homes and damaged 50 others with damage estimated to be nearly $2 million.

The death toll from Gilbert was reported to be 318. Several countries in the Caribbean reported deaths, with the toll of 202 from Mexico being by far the largest. The only deaths in the United States were three, due to tornadoes in San Antonio, Texas. The latest death statistics by country are: Mexico 202, Jamaica 45, Haiti 30, Guatemala 12, Honduras 12, Dominican Republic 5, Venezuela 5, United States 3, Costa Rica 2 and Nicaragua 2. The estimated damage throughout the area was probably near $5 billion. Jamaica had nearly $2 billion damage and in Mexico dam-



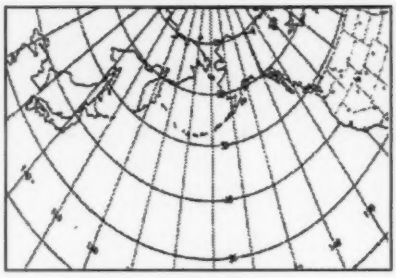
age was estimated between $1 and $2 billion dollars. Reports from the Mexican government indicate that more than 60,000 homes were destroyed in that country. The most extensive damage over the United States was in San Antonio where damage, caused by a number of tornadoes, amounted to $3 million. Elsewhere over south Texas, damage was confined to beach erosion along Padre Island and in the Lower Rio Grande where high winds and a few tornadoes downed a number of trees, signs and power lines. Total damage in the United States was estimated to be between $40 and $50 million.

Deeply–organized convection accompanied the tropical wave, that was to become **Helene**, as it moved off the African coast on the 15th of September. Showers and gusty winds of 20 to 30 kn were observed over the Cape Verde Islands as the wave passed through the area on the 17th. Strong ridging over the eastern Atlantic forced the developing system on a westerly track. The wave became a tropical depression on the 19th and strengthened to Tropical Storm Helene the following day. A major trough in the mid–Atlantic turned the storm toward the northwest on the 21st, and Helene immediately began to deepen at a moderate rate. The storm became Hurricane Helene on the 21st and, based solely on satellite estimates, deepened to a minimum central pressure of 938 mb on the 23d, when maximum winds were estimated at 124 kn. The hurricane gradually lost strength as it moved northward at 12 kn for the next several days. On the 29th, Helene's forward motion accelerated to 30 kn as it approached the strong southwesterly jet stream. Helene's speed increased to 50 kn, on the 30th, as it became extratropical and headed toward Iceland.

Casualties— On Labor Day morning (September 5th) gales struck Youngstown, OH harbor damaging a 26–ft cabin cruiser and a motor boat. A 200 thousand–lb barge broke loose from its moorings along with its tug and ran aground at Olcott, OH.

During the bad weather across Spain and France early in the month there was an incident involving a British yacht, the ***Edith Carol***. The vessel sank in violent thunderstorms off Majorca on the 1st. Two crewmen died but two teenagers were rescued by the crew of the ***Sirius***, which answered Mayday calls. The ***Laptev Sea*** suffered heavy weather damage on a voyage between Laayoune, Western Sahara and Bremen, West Germany on the 23d and 24th. On the 29th the ***Estray*** , from Rotterdam to the U.S., was allegedly damaged by heavy weather.

The Weather Logs, cyclone tracks, buoy, gales and wave tables and mean pressure charts provide a definitive report on the primary storms that affect the North Atlantic and North Pacific Oceans. The Monster of the Month is a title given to an extratropical storm that has been particularly hazardous to shipping. All storms can be dangerous. The tropical cyclones summaries are based on reports from, the National Hurricane Center, Royal Observatory at Hong Kong and the Joint Typhoon Warning Center at Guam. They are detailed but should be considered preliminary until the final reports are issued. Unless otherwise stated, winds are sustained and time is Universal (UTC). The number next to the extratropical summary corresponds to the same number on the track chart.



North Pacific Weather Log July, August and September 1988

July— The Pacific must have been named after a voyage across it in a month such as this. The subtropical high carved out a good portion of the Ocean (fig 1). There were two areas where it was not as strong as usual; one was southeast of Japan and the other was in the northeastern North Pacific and Gulf of Alaska. Negative anomalies resulted from weak but persistent extratropical activity in these waters. Pressure was above normal in the Sea of Okhotsk and the Bering Sea. At the 700–mb level, steering currents were nearly zonal over the northern shipping lanes.

On This Date —July, 1879— The first typhoon warnings were issued by the Observatorio del Ateneo Municipal in Manila. A system was established by Jesuits in 1865. These early warnings were based upon past weather patterns with some additional telegraphed data from observers at several places on Luzon.

Extratropical Cyclones— Between the subtropical high and high pressure that became established over the Bering Sea for a good part of the month, lay a stationary front. Along this front, which stretched at times from Japan to British Columbia, atmospheric waves would form and move. Sometimes they would develop their own circulation and other times they would remain as perturbations. None ever became a real threat to shipping based upon the reports that were received. For example, on the 11th, at 0000 near 44°N, 155°E, the ***Korean Wonisjin*** and the ***Prince of Tokyo*** reported east northeast winds of 54 and 47 kn respectively. Nearby a low pressure system was coming to life. However, the following day it was barely recognizable. This was the situation for most of the month. Only one storm was worth tracking and even this was suspect.

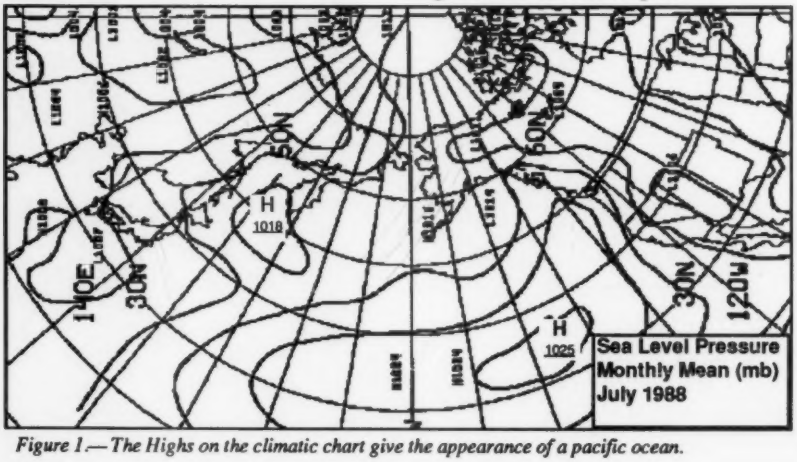


Figure 1.— The Highs on the climatic chart give the appearance of a pacific ocean.

❶ This system came to life on the 18th, southeast of Honshu, as a weak atmospheric wave along a stationary front. It headed east northeastward but intensified slowly. At 1200 on the 19th the ***Jinei Maru***, some 300mi southeast of the center, picked up 30–kn southerlies. The JQ5K ran into 30–kn southwesterlies the following day while the ***Michigan Highway*** hit a 50–kn southwesterly, just ahead of the front, some 180mi south southwest of the center. Seas were running 8 to 10 ft south and southeast of the 1001–mb center. The storm turned eastward, during the 20th, and became part of a complex system with multiple centers. It wasn't until late on the 22d that a couple of the centers merged and an organized storm appeared on a course that was turning toward the northeast and the Gulf of Alaska. By the 23d, at 1200, central pressure dropped to 998 mb. Several vessels reported winds of near–gale force during the next several days but the system did not seem to intensify further. It did remain identifiable into the 26th.

Tropical Cyclones— Tropical regions were much more active than the waters farther north. In the east, six tropical cyclones came to life in July while western waters spawned two. Prelimary reports were furnished by the National Hurricane Center in the east and the Royal Observatory at Hong Kong in the west.

An easterly wave, which moved off the African west coast on the 23d of June, became the seedling for Tropical Storm **Carlotta**. Two weeks passed as the wave made its uneventful trip across the tropical Atlantic and Central America. On the 7th of July, satellite pictures indicated a concentrated area of cloudiness and showers was developing near 12.0°N, 100.0°W. The area of showers, based upon satellite imagery, was designated a disturbance on the morning of the 8th and became a tropical depression by that afternoon. Under favorable conditions, the depression became a tropical storm at

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Figure 2.— Hurricane Carlotta poses, on the 11th of July, near the time of its peak intensity. Its relation to the Intertropical Convergence Zone can also be seen.

1200 on the 9th. Carlotta reached maximum strength (60 kn, 994 mb), at 0000, on the 11th (fig 2). During this period, the center of the storm passed 180 mi southwest of the island of Socorro, which reported northeast winds of 25 kn and a low pressure of 1009.3 mb. Thereafter, the storm moved over cooler waters and simultaneously lost the favorable upper air conditions. Carlotta was downgraded to a depression by 0600 on the 13th.

A tropical wave, moving westward around 15 kn, passed off the northwest African coast on the 4th of July. It continued across the tropical North Atlantic and Caribbean Sea without any signs of organization. After crossing Central America, on the 14th, the westward motion decreased to about 10 kn. The system began to show a gradual increase in convection and organization over the warm waters of the tropical North Pacific during the following 4 days. It was designated the sixth tropical depression of the eastern Pacific hurricane season on the 19th.

The depression was upgraded to Tropical Storm **Daniel** on the 20th, about 600 mi southwest of Baja California. A weak 200–mb outflow pattern developed over the storm on the 21st but was limited by an upper–level low just west of Baja California. A major ridge of high pressure both at the surface and aloft, over the western United States and northern Mexico, extending well out into the Pacific, steered both Daniel and the upper–level low on parallel west northwesterly tracks. Under this regime the storm was never able to develop a significant outflow pattern. The maximum sustained winds, were generally between 40 and 50 kn from the 20th to the 25th. The 200–mb outflow pattern became a little better organized, during the 23d, when the upper low turned northward and no longer was a contributing factor. At this time, Daniel reached maximum strength with winds estimated near 55 kn. However, the northwest motion brought the storm over much cooler water so that a gradual loss in convection and strength began on the 24th. Daniel was downgraded to a tropical depression on the 25th and the system weakened to a swirl in the stratocumulus field the following day.

An area of low pressure formed, southeast of Guam, on the 11th. It developed into a tropical depression, about 300 mi west–southwest of Guam, on the 14th of July and moved westward. It soon intensified to a tropical storm. On the 15th, **Warren** began to move west–northwestward at about 14 kn and became a typhoon, about 730 mi east of Manila, the next day (fig 3). It passed the northern tip of Luzon early on the 18th. Heavy rain resulted in severe flooding in the northern Philippines, where at least one person was killed and 4,000 had to flee their homes. Thousands of hectares of rice and corn fields were ruined. The ***Thita Horizon*** also capsized and sank off the coast of Ilocos Sur Province. Warren then entered the South China Sea on the afternoon of the 18th and moved west–northwestward. It passed about 60 mi northeast of Dongsha on the 19th. At 2 pm (LST) the ***German Senator*** reported a pressure of 977.5 mb, about 24 mi southeast of the center. Warren made landfall over eastern Guangdong about 150 mi east northeast of Hong Kong, around 4:30 pm. Warren continued its northeastward movement and finally dissipated inland in northern Guangdong early on the 20th.

In Hong Kong heavy rain associated with Warren caused severe flooding in several parts of the New Territories. According to press reports, flooding also occurred in Shenzhen. Damage in Shan-

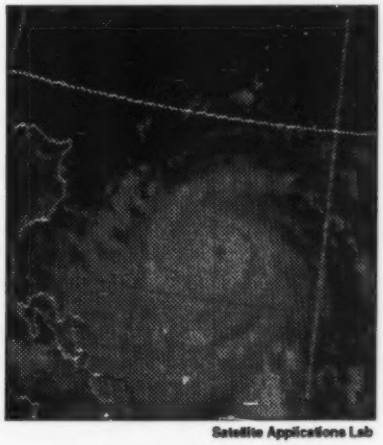

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Figure 3.— Warren, at 0100 on the 17th, is approaching Luzon.

tou was more severe. Six people were killed and 106 people injured. About 4,500 houses and 143,000 huts collapsed. Seven ships were sunk and another 187 damaged.

A tropical wave passed off the northwest African coast on the 15th. The wave moved at 18 kn across the tropical north Atlantic and Caribbean Sea without any signs of organization. This rapid westward movement was maintained after crossing Central America on the 24th. The system began to show an increase in convection, throughout the 25th, as it moved into the Pacific. The disturbance became the seventh tropical depression of the eastern Pacific hurricane season on the 27th.

After gradually strengthening, the depression was upgraded to Tropical Storm **Emilia**, on the 29th, about 600 mi southwest of Baja California. Although Emilia spent its life over water warmer than 26°C, it was destined to remain a tropical storm since it could never develop deep convection entirely around its center. After a peak intensity of 60 kn was reached, on the 30th, satellite imagery showed Emilia overwhelmed by vertical shear. The vertical shear continued to weaken the system and it turned to depression status on the 1st of August.

The first hurricane of the season to move into the Central Pacific Hurricane Center's area of responsibility originated within an area of disturbed weather, over the eastern North Pacific. By the 26th of July, the Intertropical Convergence Zone (ITCZ), over the eastern Pacific, had become active with the appearance of several organized clusters of thunderstorms. One of three clusters became better organized. The disturbance became the eighth tropical depression of the eastern Pacific hurricane season, on the 29th, about 900 mi southwest of the southern tip of Baja California.

The depression moved westward at 10 kn and gradually intensified, becoming Tropical Storm **Fabio** on the 29th and reaching hurricane strength on the 31st. The system steadily intensified and gradually accelerated to near 12 kn while turning west northwestward on the 3d of August. Based on satellite intensity estimates, Fabio reached its maximum strength of 120 kn (943 millibars) on the 3d (fig 4).

NOAASatellite

Figure 4.— Hurricane Fabio was sporting top winds of 120 kn when this enhanced photo was taken, at 1216 on the 3d of August.

With Fabio's west northwestward motion in the direction of the Hawaiian Islands, the Central Pacific Hurricane Center issued a tropical storm watch at 0300 on the 4th, for the big island of Hawaii only. Later, as the influence of the upper trough diminished, Fabio turned back to the west with a decreased speed of 10 kn or less. Fabio appears to have weakened fairly rapidly after reaching its maximum intensity, being downgraded to a tropical storm on the 5th and to a depression on the 6th.

A large tropical wave, that moved off the northwest coast of Africa on July 7th, was the embryo that eventually became Tropical Storm **Gilma** in the eastern Pacific about 3 weeks later. On the 19th, the system appeared in the eastern Pacific, as an area of disturbed weather about 700 mi southeast of developing Tropical Storm Daniel. The poorly organized area continued moving westward, roughly along 12°N, for about a week without signs of development. The first sign was detected, on the 26th and 27th, in the form of an incipient banding pattern. It was estimated that the system became a tropical depression at 1200 on the 28th near 15.5°N, 135.0°W.

Tropical Depression Ten–E moved very little during the next 24 hr and became better organized over 26°–C sea surface temperatures. The depression became Tropical Storm Gilma at 0600 on the 29th near 15.7°N, 135.0°W. Although some increase in maximum sustained winds followed, significant strengthening was limited due to the presence of shearing aloft. By 1800 on the 30th, satellite animation showed even less organization and Gilma likely became a depression near that time.

Tropical Depression Gilma was weakening with maximum sustained surface winds estimated at 30 kn as she entered the Central Pacific Hurricane Center's (CPHC) area of responsibility during the evening of the 30th near 17°N, 140°W. Gilma was over cooler sea surface temperatures as she moved in a west northwesterly direction on a course taking her up the windward side of the main Hawaiian Islands. The center of the weakening depression moved very close to the

islands of Maui and Molokai on the evening of August 2d, and over Oahu and just south of Kauai early on the 3d. Gilma was dissipating as she glided past Oahu and Kauai. A few cumulonimbus clouds did spring up north of the center as the system began to react with a cold upper level trough located just to the northwest of the islands. Some welcome rain fell over the islands of Kauai and Oahu, where locally heavy amounts in the 2 to 4 in range, were reported.

Hector's circulation originated in an area of disturbed weather, on the 30th of July, about 400 mi south of Acapulco, Mexico. The depression moved west northwestward at 13 kn and gradually intensified, becoming a tropical storm on the 31st and a hurricane on the 2d of August. It continued this course at a slightly slower speed, of 10 kn, and continued to intensify. Based on satellite intensity estimates, it reached its maximum strength of 125 kn (935 millibars) on the 3d.

The hurricane turned due westward on the 5th, having weakened to an estimated 85 kn by this time. It appeared to strengthen again, briefly, on the 6th, but steadily weakened thereafter and finally lost its circulation on the 9th, some 650 mi east of Hilo, HI. The Central Pacific Hurricane Center (CPHC) assumed warning responsibility when Hector crossed 140°W, at about 0000 on the 9th, as a rapidly weakening tropical depression. The weakening trend continued as the depression made its way westward.

The remnants of Hector were carried along by trade winds and into the Hawaiian Island chain, on the 11th, causing some heavy showers on the island of Kauai, where more than 6 in of rain fell in the mountains and, locally, along the north shore. At the same time, moisture from a tropical disturbance, passing to the south of Hawaii, made its way northward and caused some heavy thunderstorms over the Big Island where lightning, in the Volcano National Park area, was reported to have struck two people.

Casualties— The ***Thita Horizon***, mentioned in the summary of Typhoon Warren, capsized and sank about 200 mi north of Manila on the 19th, after being battered by huge waves. Fishermen rescued the Greek master and seven crewmen from a rubber raft. In southeastern South Korea rain storms on the 20th were responsible for 14 deaths and 10 people missing. Six people were caught in a mudslide in Youngwol, 85 mi southeast of Seoul, where more than 10 in of rain fell during the day.

August— Not only was the sutropical high in place (fig 5) on the climatic charts for August, but it was slightly stronger than normal for most areas. Over the Bering Sea a –5mb anomaly indicated storm activity was a little above normal. For the most part the high forced the extratropical storms northward. In the steering currents at 700 mb flow was nearly zonal from 170°E and 160°W between 40°N and 50°N. To the west and east the curvature was cyclonic around the upper low centered just south of the Bering St. In the ideal setup a storm over southern Kamchataka would end up near Queen Charlotte Is.

On This Date — August 30, 1968 — Twenty years ago Super Typhoon Wendy was a raging monster with 140–kn winds around a 917–mb pressure, near the Mariana Is. A few days later, on the 3d of September, Agnes was generating 150–kn winds around a 904–mb center.

Extratropical Cyclones— While activity was not confined to the Bering Sea, it was the favored location. Like the Aleutian Low, the subtropical high is often made up of a number of pressure systems throughout the month. However the high can also come from just a few anticyclones and is often a semipermanent feature. When this occurs, as it did in August, it can protect a large portion of the Pacific from cyclones.

❶ The month began with a bang, east of the Kamchatka Peninsula, when a storm developed very rapidly on the 1st. Before the day was out, central pressure was down to 972 mb. At 0600 on the 2d, the ***Svetlaya*** reported in with a 58–kn north wind in 13–ft seas, near 55°N, 154°E. Six hr later the ***Antiia*** hit 48–kn winds some 350 mi north of the 970–mb center. The storm turned sharply eastward and then headed northeastward on the 3d. Ship reports became scattered as the system began to fill and head into less frequented waters. On the 6th, it moved across Norton Sound and found its way over the Alaska mainland.

❷ The only other extratropical storm of note, came to life on the 26th near 46°N, 157°W. By 1200 the following day, central pressure had fallen to 984 mb. At 0000 on the 27th, the DULT was already experiencing 47–kn southwesterlies, near 45°N, 154°W; this was about 240 mi

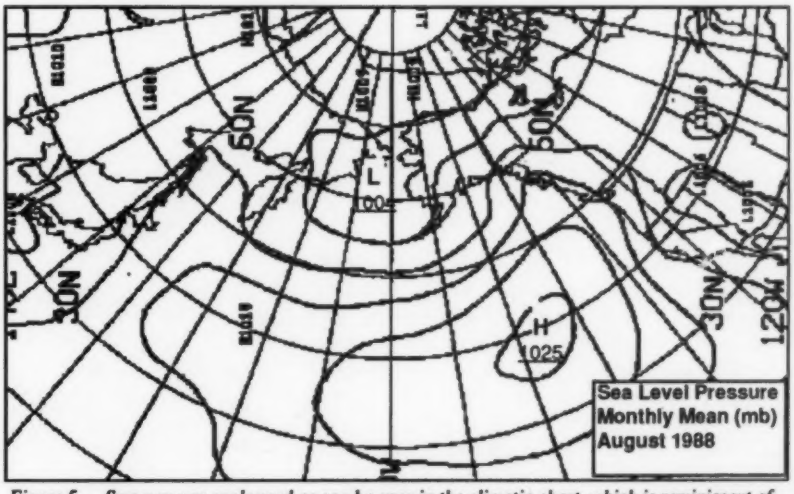

Figure 5.— Summer was prolonged as can be seen in the climatic chart, which is reminiscent of average August weather.

south of the storm's center. Twelve hr later, the ***Unitrust*** hit 40–kn southeasterlies some 300 mi northeast of the storm center. The northward–moving storm made a turn to the northeast at this time. The ***Tristan***, at 0000 on the 28th, encountered 47–kn south southeast winds, in 15–ft swells, near 54°N, 148°W. Winds, in general, were ranging from 40 to 45 kn as the system neared the Gulf of Alaska. The ***Tristan***, at 0600 on the 29th, was still battling 47–kn winds but seas were up to 25 ft. Later in the day it weakened significantly.

Tropical Cyclones— It was a busy, month in the Pacific. Five tropical cyclones formed in the west while the east spawned a total of four. The western preliminary report was provided by the Royal Observatory in Hong Kong, while the summary for the east was done by the National Hurricane Center.

Of the five tropical cyclones that occurred over the western North Pacific in August, one made landfall over eastern China and moved far inland. Two spent their lives over open waters. At the end of the month, the other two were still active over the ocean. No tropical cyclone occurred over the South China Sea in August, for the first time since 1985.

An area of low pressure formed to the south of the Ryukyu Islands on the 4th. It developed into a tropical depression, about 120 mi south southeast of Okinawa on the 6th, and was named **Bill**. Bill moved slowly northward, initially, and accelerated northwestward in the evening, passing about 10 mi southwest of Okinawa. Rapid intensification took place on the morning of the 7th and Bill became a severe tropical storm that afternoon. Continuing across the East China Sea, it turned west northwestward and later made landfall, over Zhejiang Province, about 100 mi south southeast of Shanghai around midnight of the 7th. Shortly after landfall, Bill reached its maximum intensity (fig 6). Its center passed very near to Hangzhou early on the 8th. Bill moved into Anhui Province and weakened to a tropical storm, about 130 mi west northwest of Hangzhou, in the afternoon. It finally dissipated in Hubei Province the next day. In Zhejiang Province the damage was extremely serious. According to press reports, a total of 10.5 million people were affected. The death toll was 160 and 1232 people were injured. Over 47,000 houses collapsed and 144,500 houses were damaged. In the coastal regions over 1000 boats sank. According to press reports, this was the most severe natural disaster in 40 yr in Zhejiang. The scenic capital of the province, Hangzhou, suffered a direct hit. About 20,000 trees were brought down by storm–force winds and violent rain. Electricity and water supplies were interrupted. In Anhui Province, the passage of Bill also resulted in collapse of houses and interruption of electricity and telecommunications.

Clara formed, as a tropical depression on the 10th, about 640 mi north northwest of Wake Is. It drifted slowly westward and became a tropical storm early the next day. Clara moved north northeastward but turned again toward the northwest on the 13th. It weakened to a tropical depression 860 mi northeast of Tokyo on the 14th and dissipated the next day.

A tropical disturbance developed into Tropical Storm **Doyle**, about 100 mi east northeast of Wake Island, on the evening of the 15th. It moved westward, and, at the same time, intensified rapidly. Doyle became a typhoon the next day about 145 mi northwest of the island. It then began to recurve towards the northeast. Typhoon intensity was maintained until the 21st when it was about 600 mi northeast of Midway Is. Doyle slowed and turned eastward on the 22d. It weakened into a tropical depression the next day and finally dissipated, about 665 mi north northwest of Midway Is, early on the 25th.

Elsie developed as a tropical depression, about 900 mi northeast of Guam, on the 28th and moved southeastward. It intensified to a tropical storm the next day and turned north northeastward. On the 30th, Elsie changed course again toward the northwest and it remained so at the end of the month.

Fabian formed as a tropical depression, about 350 mi southeast of Tokyo, on the 30th. It moved slowly eastward and soon became a tropical storm. Fabian further intensified to a severe tropical storm, about 480 mi east southeast of Tokyo, on the 31st. At the end of the month, it was moving towards the east.

The tropical wave that moved off the African coast, on the 26th of July, became the seedling that produced hurricane **Iva**. The wave remained easily identifiable on

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Figure 6.— Bill reached maximum intensity after it made landfall. This was taken at 0500 on the 8th.

its trek across the Atlantic basin due to the continuous convective activity associated with it. However, it was not until the wave moved into the more fertile atmosphere of the eastern North Pacific, on the 4th of August, that organized convection developed. The wave developed into a tropical depression by 0000 on the 5th and reached storm strength 24 hr later. The storm continued strengthening as it moved west northwestward; it developed to hurricane strength by 0000 on the 7th.

Hurricane Iva turned toward the northwest on the 7th and, based upon satellite classification, reached its lowest pressure of 986 mb at 1200 on the 8th. Iva passed within 50 mi of the island of Socorro at 0600 on the 8th. Synoptic reports from the island at 0600 indicated a northeast wind of 40 kn, a 999.5–mb pressure and moderate rain. Within 24 hr Iva moved over cooler waters and began to weaken. The hurricane was downgraded to a tropical storm at 1800 on the 9th and lost all deep–organized convection by midday on the 10th.

A tropical wave tracked from the African coast on the 3d of August developed into a Pacific tropical depression just off the southwest coast of Mexico on the 16th. The 14th tropical depression of the season was classified by satellite about 150 mi southwest of Manzanillo, Mexico.

The depression moved slowly northwestward and, less than 24 hr after formation, was a tropical storm. **John** moved northwestward between 5 and 10 kn as a minimal tropical storm for a short period. Satellite pictures showed the low–level center becoming more exposed with time. John was downgraded to a tropical depression on the 18th. The following day, the depression stalled and made a cyclonic loop less than 100 mi south of the southern tip of Baja California. After completing the loop, Tropical Depression John became a little better organized. However, this attempt to regain tropical storm status was short–lived and the system lost all identity during the 21st as it drifted northwestward parallel to the southwest coast of Baja California.

Satellite classification indicated the maximum sustained winds in John were 35 kn with an estimated minimum pressure of 1004 mb. A few ships reported winds of 30 to 35 kn, just off the mountainous coasts of southwestern Mexico. These winds appeared to be orgraphically induced and were well away from the center of John.

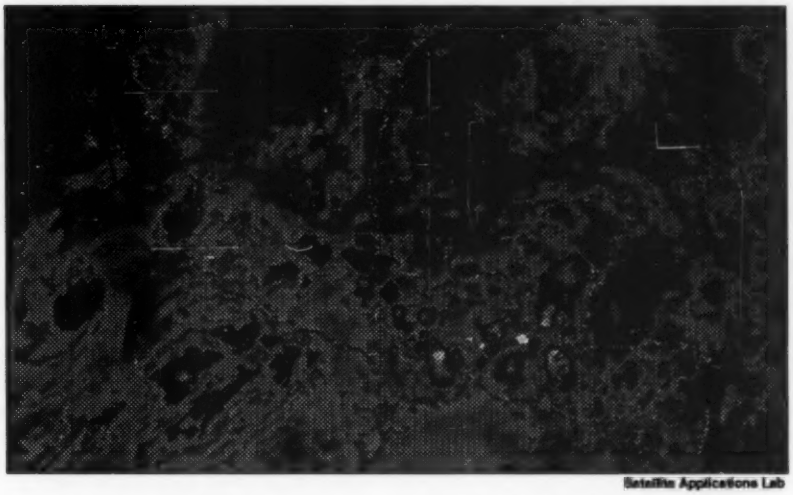


Figure 7.—This enhanced view of Kristy was made on the 1st of September, at 0031, while a hurricane south of the Baja.

A tropical wave passed off the northwest African coast on the 12th of August. It crossed the tropical Atlantic without development until the 19th when, near longitude 55°W, it began showing signs of organization. The next day this system became Tropical Depression Six for the Atlantic basin. It was tracked form the Windward Islands into the central Caribbean. The depression was downgraded to a tropical disturbance on the 23d. It passed across Central America with minimal convection.

This convection began reorganizing on the 28th and the system became Tropical Depression Sixteen–E for the Eastern Pacific at 0000 on the 29th about 300 mi south southeast of Acapulco, Mexico. At 1200 the same day the depression became Tropical Storm **Kristy**, because ship reports indicated wind speeds of 35 kn or greater. Based on satellite imagery, this developing system became a hurricane on the 31st (fig 7).

The hurricane stage only lasted until the 2d of September when the system was downgraded to tropical storm status. Kristy was short–lived because its westerly track took the system across the southern quadrants of a strong quasi–stationary, upper–level anticyclone located south of Baja California. The strong easterly vertical wind shear, associated with the anticyclone caused Kristy's deep convection to be displaced to the west of the low–level center. Finally, by the 3d, Kristy was devoid of deep convection.

A disturbance some 800 mi to the southeast of the Big Island of Hawaii showed signs of development and was tagged Tropical Depression (TD) ONE–C on the 28th of August. It moved westward, while intensifying, and was upgraded to tropical storm **Uleki** as it neared 13°N, 149°W, at 1800, on the 29th. Uleki continued to intensify and, within 36 hr, was upgraded to a hurricane, about 350 mi south of Hilo. During the next 12 to 18 hr Uleki experienced explosive intensification, with winds estimated by Air Force Hurricane Hunters to be 100 kn by 1800 on the 31st. Maximum intensity was reached about 24 hr later, when wind speeds near the center were estimated to be 110 kn. Until this time, Uleki moved at a fairly steady rate toward the west. However, on the 2d and 3d of September, Uleki stalled and began to drift slowly northward.

The people of Hawaii experienced some anxious moments when Uleki stalled so close to the Islands. It was extremely

helpful to the CPHC forecasters to have aerial reconnaissance available to continuously monitor the position and intensity of the threatening cyclone. U.S. Air Force reconnaissance crews flew a total of 10 missions and provided 41 center fixes on Uleki between the 31st of August and September 5th. Estimated maximum sustained surface winds were 110 kn, with the lowest sea level pressure determined by dropsonde at 957 mb.

Uleki experienced a slow weakening trend as it paused southwest of the Islands. This trend continued as the once powerful hurricane moved westward. The minimal hurricane had little or no impact on the weather at Johnston or French Frigate Shoals. The weakening of Uleki stopped, during the evening of the 6th, as a favorable upper flow and warmer sea surface temperatures caused reintensification with winds increasing to 90 kn.

Continuing west northwestward, Uleki passed to the south of Midway Is. Maximum winds, at Midway, were 22 kn gusting to 31 kn at 0101 on the 8th. The CPHC passed warning responsibility to the Joint Typhoon Warning Center (JTWC) at 0000 on the 8th, and Uleki became a typhoon. Uleki remained an intense typhoon west of the dateline for several days.

Casualties— See Tropical cyclone summaries.

On This Date — September 27, 1968 — Supertyphoon Elaine, 150 mi off Luzon, was generating 150–kn winds around a 908–mb center. It slammed into Luzon the following day. During its final stages, the ***Bangkok Trader*** was disabled in the southern entrance to the Taiwan St. Some 31 crewmen were rescued by the ***Nagan Chau*** but 6 men lost their lives.

Extratropical Cyclones— Considering the size and extent of the Subtropical High, the track chart shows a number of extratropical storms across the shipping lanes. However most were not intense winter storms.

In an interesting development, a cruise ship, ***Society Explorer***, with 158 people aboard, became trapped by thick ice in Beaufort Sea while traversing an east–west navigation of the Northwest Passage. It had left Dutch Harbor on August 19th. The U.S. Coast Guard icebreaker ***Polar Star*** was summoned, with the permission of the Canadians, to help. The ***Polar Star*** was within 90 miles of the ***Society Explorer*** when the crew of the latter vessel radioed that they had eased their way into open water, on the 4th of September. The ***Polar Star*** then turned her attention to the ***Shaylen Nicholas***, which had been immobolized for a week.

● On the 5th, one of several atmospheric waves popped up along a front, near 35°N, 150°E. This center remained weak as it moved toward the east northeast for the next few days. However, by the 8th, it began to develop a recognizable circulation. Within 24 hr, the central pressure dropped from 1004 mb to an estimated 980 mb. At 0000 on the 9th ***Elbe Maru***, near 49N°, 169°W, ran into 40–kn east southeasterlies in 16–ft seas. Winds continued in the 40– to 45–kn range throughout the day. At 0000 on the 10th, a ship near 54°N, 171°W reported a 48–kn northerly and the ***Miller Freeman*** confirmed this with a 46–kn reading, nearby. By this time the system was nearing 50°N, 170°W. At 1200 the center was over the Alaska Peninsula and a secondary center had developed to the east. Gales were still being reported but less frequently. The storm moved inland and began to weaken on the 11th.

● **Monster of the Month**— Former Typhoon Hal turned extratropical on about the 17th, near 43°N, 160°E. At this time (0000) its central pressure was 976 mb. This was a drop from 997 mb at 1800 on the 16th. The ***Tian Shan Hai***, near 43°N, 150°E, ran into 45–kn north northeasterlies in 26–ft seas. At 0600 the ***Asano No 1*** and ***Claro*** were reporting winds in the 40–kn range; the ***Claro*** was battling 33–ft seas. As the system turned toward the northeast on the 18th, winds in the 40– to 45–kn range became the

September— At sea well as on land its nice to see summer prolonged. This year the North Pacific Subtropical High maintained an August appearance through September. The only exception was off the coast of Japan where tropical cyclones kept pressure a little below normal (fig 8). Positive anomalies extended over the rest of the North Pacific, Bering Sea and Sea of Okhotsk. At the 700 mb level, troughing over western Alaska helped curve the steering currents in a cyclonic fashion. The general trend between 40° about 50°N was east northeastward from Japan to about 170°W, then curving more toward the northeast. So, in this ideal setup, a storm over Hokkaido would end

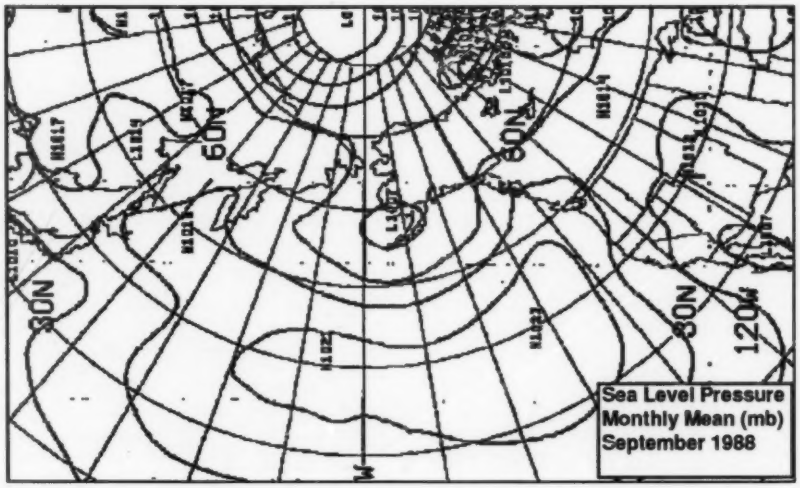


Figure 8.— Another month with summer extended. The subtropical high has been strong all summer and continues right into the fall— a welcome sight for mariners.

rule and swells were running 15 to 25 ft. It looked like the system was gradually weakening. Then on the 18th, from 1200 to 1800, the central pressure dropped from 976 mb to 958 mb and the monster was back in business. The ***Noble Star*** reflected this change with a west northwesterly wind of 72 kn, some 240 mi west of the center; at 0600 on the 19th she came in with a 68–kn westerly in 16–ft swells. The ***Kure Maru***, at 0600 near 50°N, 169°W, encountered 23–ft swells although her winds were 42 kn. The pressure had dipped to an estimated 950 mb by 0600 on the 19th (fig 9). The system moved into the eastern Bering Sea on the 19th and began to fill. It moved through Bristol Bay and onto the Alaskan mainland by the 20th.

● This storm came to life, on the 26th, near 50°N, 175°W. It moved eastward, on the 27th, then began to recurve into the Gulf of Alaska. By 0600 on the 27th, its central pressure had dropped to 969 mb. At 1200 the NAQD hit 57–kn westerlies, in 16–ft seas, about 350 mi south of the center. At this time winds in the 45– to 50–kn range were common. By 0000 on the 28th, the 968–mb center was turning toward the northeast. Gale force winds and 10– to 20– ft seas continued to rake these seas. There was a noticeable fall–off in gale reports, during the day, as the storm began to slowly weaken. Several vessels including the JBJX, ***Miller Freeman*** and ***Kee Lung*** continued to report 40–to 45–kn winds south of the center early on the 29th. By late in the day the system had fallen apart.

Tropical Cyclones— Tropical cyclone activity over the western North Pacific and the South China Sea was very intense in September. Since 1946, this was the fifth time when as many as eight tropical cyclones formed in the western North Pacific during the month of September. In addition, two tropical cyclones, which formed in August, continued to exist in September, making a total of 10 tropical cyclones occurring in the area.

The two tropical cyclones that were affecting the western North Pacific in August were Elsie and Fabian. Tropical Storm Elsie moved northward and weakened on September 1st. It became extratropical, about 900 mi east–northeast of Tokyo, later in the day. Severe Tropical Storm Fabian turned abruptly northward on the 1st of September. It further intensified to a typhoon, about 700 mi east of Tokyo, on the 2d. Fabian then weakened to a severe tropical storm and moved rapidly northeastward early on the 3d. It became extratropical, about 850 mi east–northeast of Tokyo.

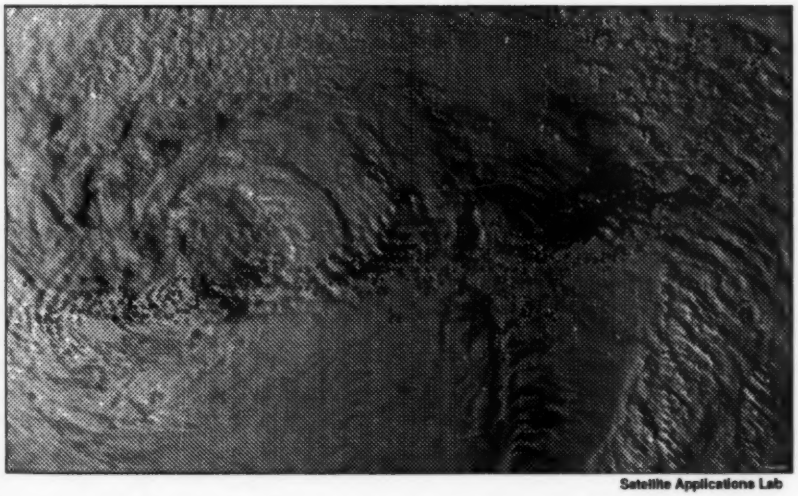
Gay was the first tropical cyclone to develop in September. It formed as a tropical depression, about 600 mi southwest of Tokyo, on the 2d and moved steadily northeastward. It intensified to a tropical storm early the next day but weakened to an area of low pressure, about 300 mi south of Tokyo, that night.

Typhoon **Uleki** formed in the central North Pacific Ocean and crossed the International Date Line, about 220 mi southwest of Midway Island, on the 8th. Uleki weakened to a severe tropical storm on the 12th. It became extratropical on the 13th, about 1300 mi east of Tokyo.

Just before Uleki crossed the International Date Line, on the 8th, **Hal** developed, as a tropical depression, about 1360 mi southeast of Tokyo. It moved northwestward and intensified, to a tropical storm, the next day. Hal turned southwestward on the 10th. It reached typhoon intensity on the 11th. Hal made a sharp turn, early on the 12th, moved north northwestward, and recurved to the northeast, at about 8 kn, on the 15th. It accelerated to 30 kn and became extratropical on the 17th. Although Hal did not move over Japan, high seas, associated with its circulation, affected the southeastern shores of Honshu. Two people were reported missing and 13 other injured.

Irma intensified to a tropical storm about 410 mi west–northwest of Wake Is. Irma was a very compact system. Severe tropical storm strength was reached two days later, about 650 mi northwest of Wake Is. Irma weakened to a tropical depression during the evening of the 15th. It further weakened to an area of low pressure about 864 mi east southeast of Tokyo and recurved to the northeast.

An area of low pressure formed to the east of northern Luzon on the 11th. It developed into Tropical Depression **Jeff**, about 840 mi east of Manila, early on the 14th. Jeff moved steadily northeastward at about 11 kn and soon intensified to a tropical storm. It weakened during the night of the 15th and became an area of low pressure, about 685 mi south of Tokyo on the 16th.



Satellite Applications Lab

Figure 9.—This VHRR of ex Typhoon Hal, turned monster of the month, was taken at 0138 on the 19th.

Tropical Depression **Kit** formed, about 290 mi east northeast of Manila, on the 19th. It moved northwestward, initially, and then turned westward, toward Luzon, at about 12 kn. Kit crossed the northern part of Luzon. It entered the South China Sea, on the morning of the 20th, and moved northwestward. Kit became a tropical storm in the evening. On the morning of the 21st, Kit became a severe tropical storm about 95 mi east southeast of Dongsha. It passed about 55 mi northeast of the Island and reached tyhpoon strength that evening (fig 10). However it weakened to a severe tropical storm early on the 22d, as it made landfall about 120 mi east northeast of Hong Kong. It dissipated overland a short time later.

Kit did not bring much rain to Hong Kong. However, according to press reports, torrential rain occurred near landfall in the Shantou area. Eight people were killed and over 100 were injured. In Fujian Province, heavy rain, due to the remnants of Kit and tropical cyclone Mamie, resulted in nine people killed.

While Kit was approaching the south China coast on the 21st, **Lee** formed about 590 mi southeast of Okinawa. It moved westward and intensified to a tropical storm that evening. Early the next morning, Lee turned northwestward and continued that track for 2 days. It recurved to the northeast, about 180 mi south southwest of Okinawa, during the night of the 23d. Lee accelerated northeastward and weakened to a depression, early on the 25th. It became extratropical later in the day before reaching Japan.

Tropical Depression **Mamie** developed, about 135 mi south southwest of Xisha, late on the 21st. It intensified to a tropical storm the next day. Mamie passed about 20 mi east of Xisha. It turned northeastward then northward again about 90 mi south southeast of Hong Kong. Under the influence of a cool northeast monsoon it finally weakened, some 30 mi east northeast of Hong Kong on the morning of the 24th.

Based on upper air soundings and satellite imagery, the system that later became Hurricane **Lane** moved westward off the African coast, on the 10th of September, as a tropical wave. The system became diffuse as it tracked at low latitudes across the tropical Atlantic and the northern portion of South America. By the 20th the wave emerged over the warm waters of the eastern Pacific and manifested itself as a distinct northward bulge in the Intertropical Convergence Zone. Deep convection organized as the system developed into a tropical depression, early on the 21st, about 300 mi south southeast of Acapulco, Mexico. The low– level circulation center became better defined and the system was upgraded to Tropical Storm Lane late on the 21st. Steady development continued and hurricane strength was reached on the 23d.

Late on the 24th, the upper level outflow over the north and west quadrants became disrupted in response to a trough to the northwest of the system. Convection began diminishing as the eye disappeared. Weakening continued as Lane was downgraded to a tropical storm on the 27th and to a tropical depression on the 28th. By late on the 28th, nearly all deep convection had been lost as the system moved over cooler waters, and Lane appeared as a low–level swirl in the stratocumulus clouds. Satellite classifications indicated the maximum sustained winds in Lane were 90 kn with an estimated minimum sea level pressure of 970 mb. A few ships reported 35–kn winds during the earlier stages of Lane.

Wila was the second tropical cyclone to develop within the CPHC area of responsibility. The first advisory on Tropical Depression TWO–C was issued at 0000 on the 21st. An area of convection, near 12°N, 142°W, showed signs of development. TW0–C was, however, slow in getting organized. It drifted slowly, first westward and later northwestward, over the next day or two, with winds estimated at 25 kn near the center. Some intensification occurred as the depression moved northeastward. The slight intensification was confirmed by an Air Force reconnaissance plane investigating the circulation. It measured winds of 40 kn near 17°N, 145°W. Based on the observations received from the reconnaissance aircraft, TWO–C was upgraded to a tropical storm, at 0000 on the 25th, and named Wila. Wila's life as a tropical storm was short lived— 18 hr — as the system, devoid of any deep convection, quickly weakened. Wila was downgraded to a tropical depression. Moisture carried along with the remnant circulation produced a few heavy showers over the Hawaiian Islands on the 26th and 27th.

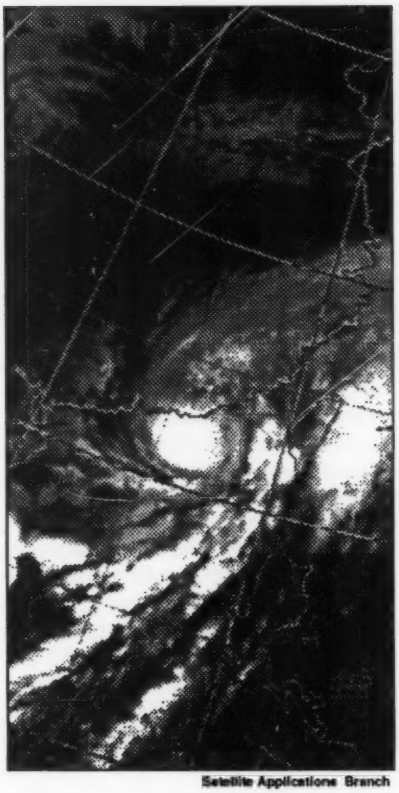


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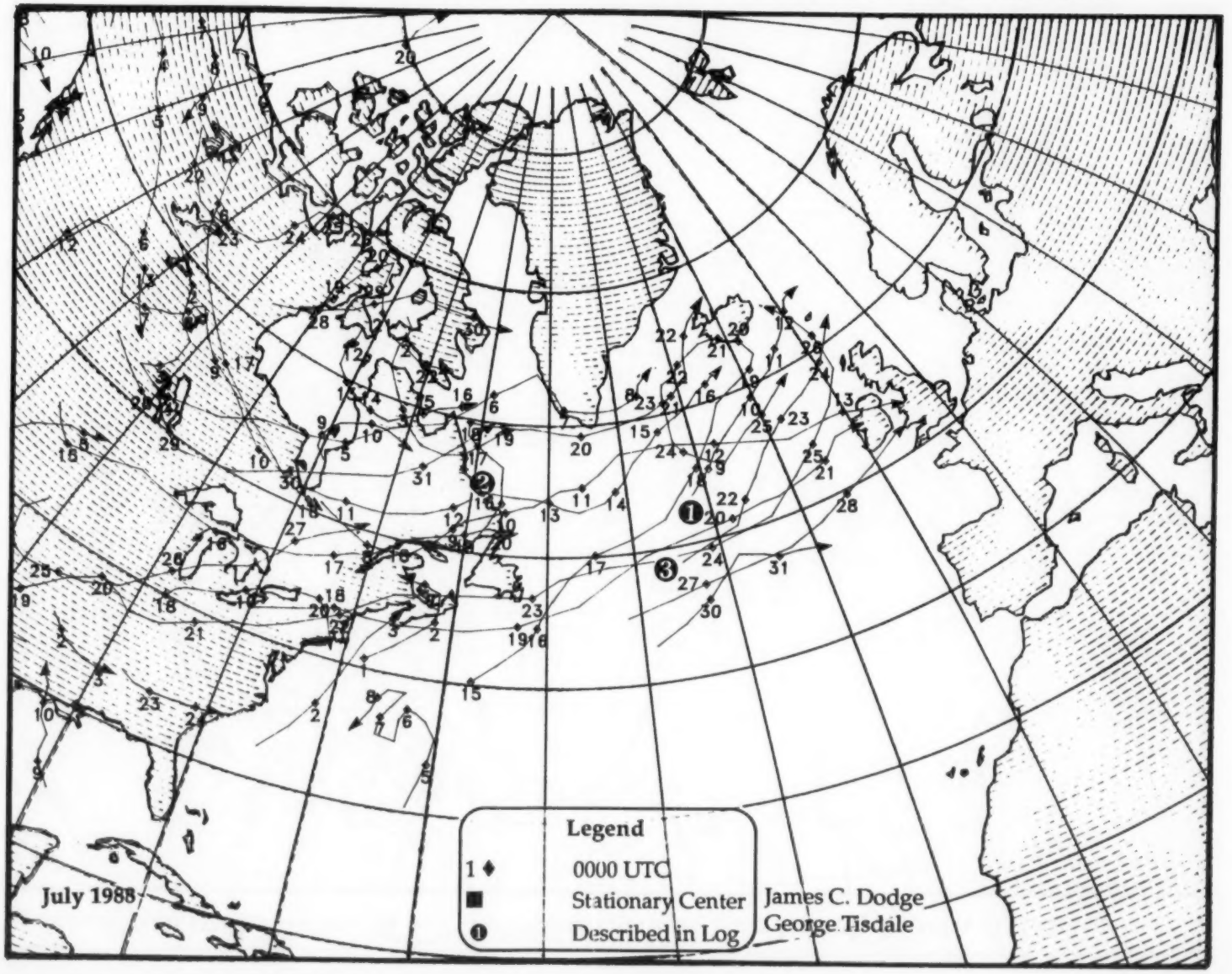
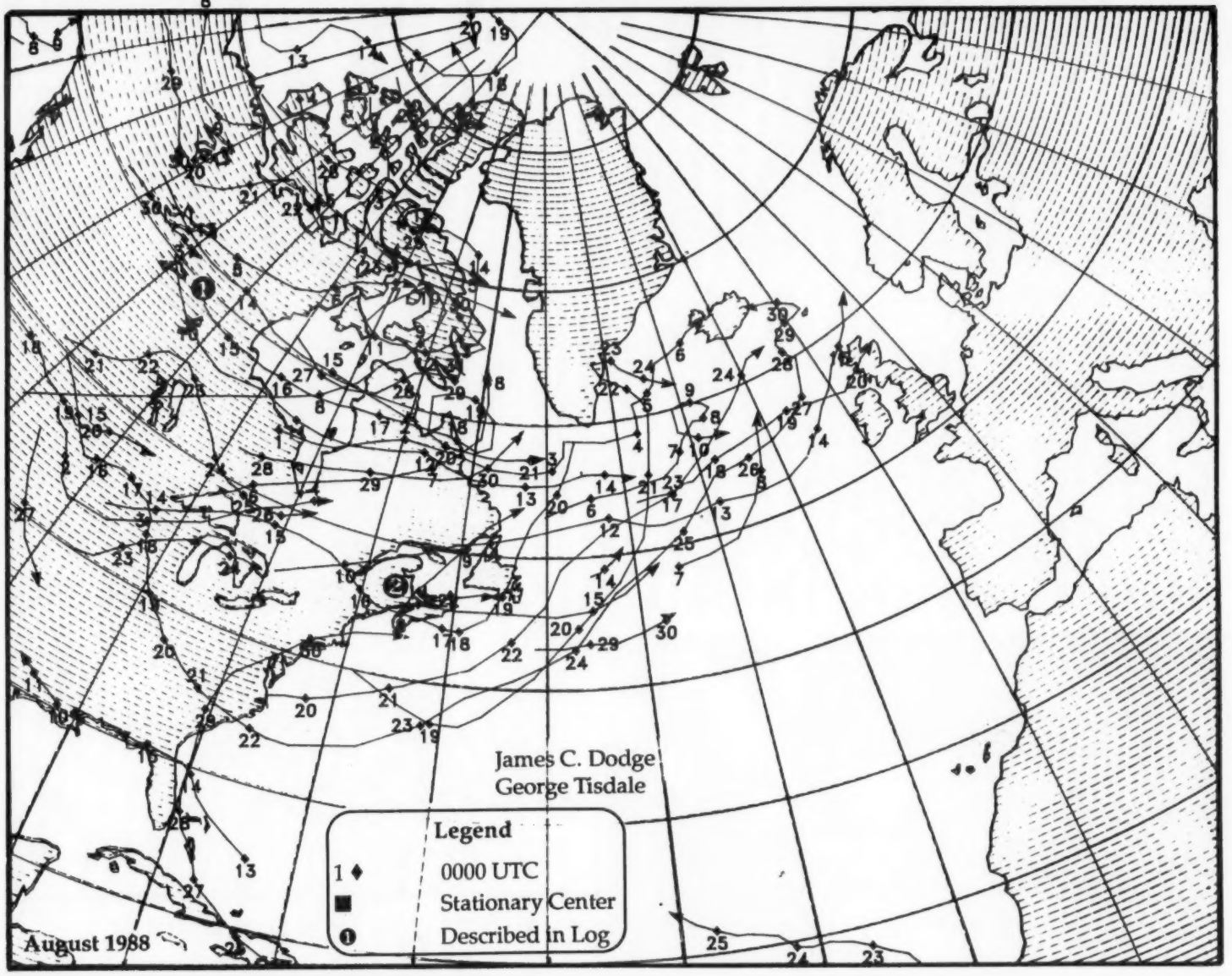
Figure 10.—Typhoon Kit had just attained that status, as it approached the Chinese mainland, at 1800 on the 21st.

Casualties— During a local storm at Keelung, crane barges working offshore sustained weather damage and anchor line failure on the 25th and 26th. Local tugs could not render assistance due to sea conditions. Finally help was provided by the ***Ragina Viking***. Also on the 26th, the ***Dock Express France***, carrying an erected container crane, reportedly experienced heavy weather on a voyage from Ulsan, Korea to Portland, OR. The container crane collapsed.

Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



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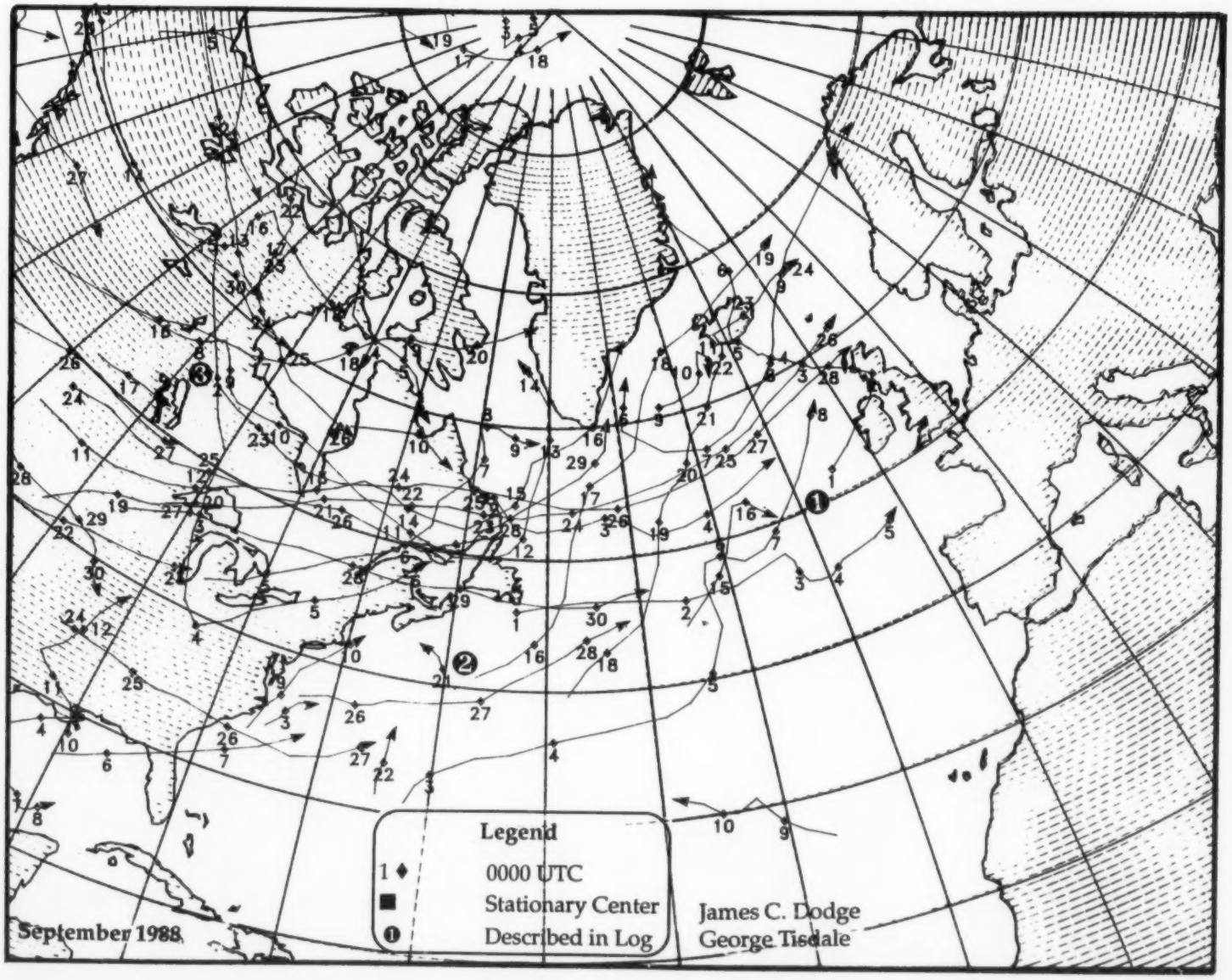
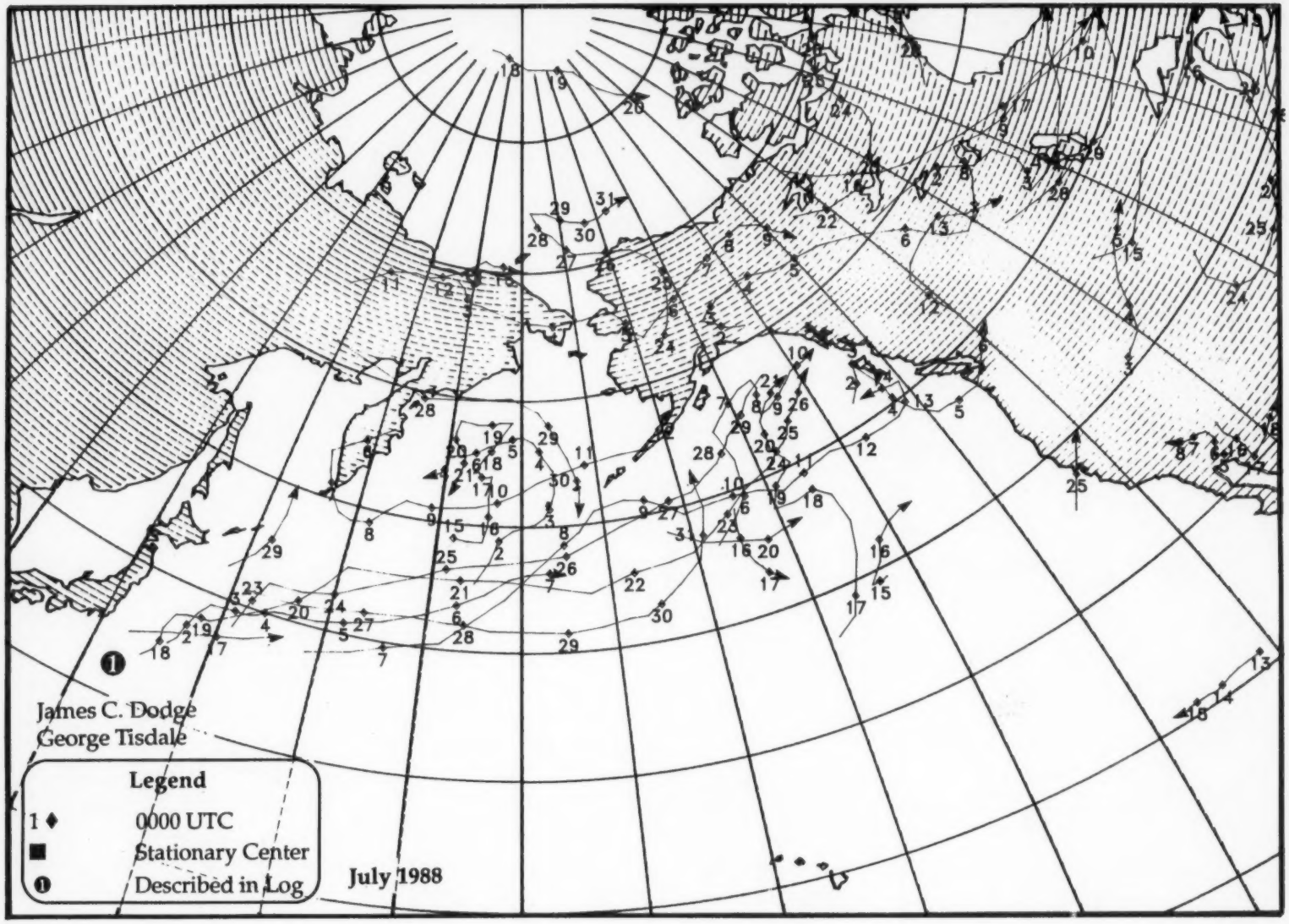
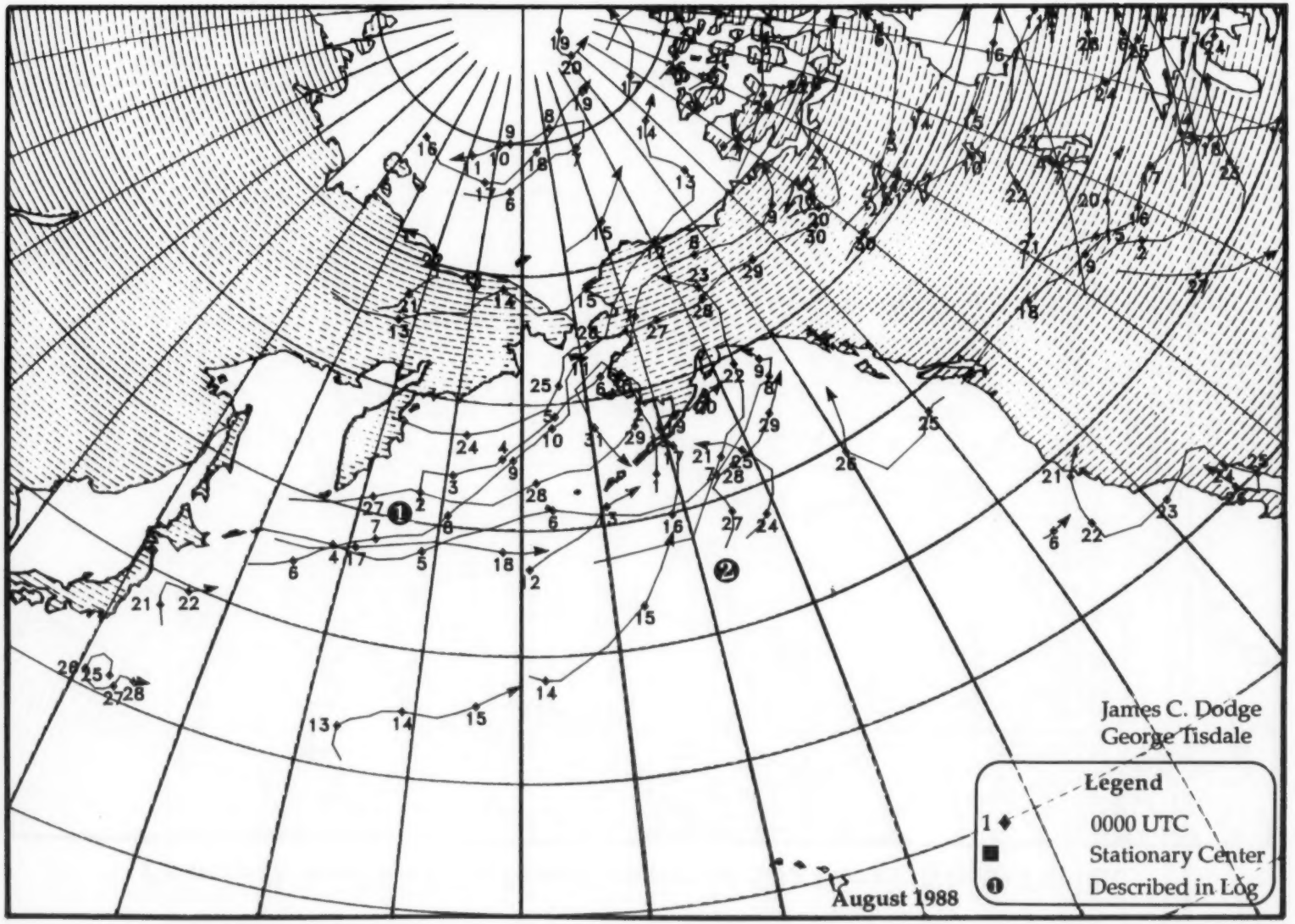
Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



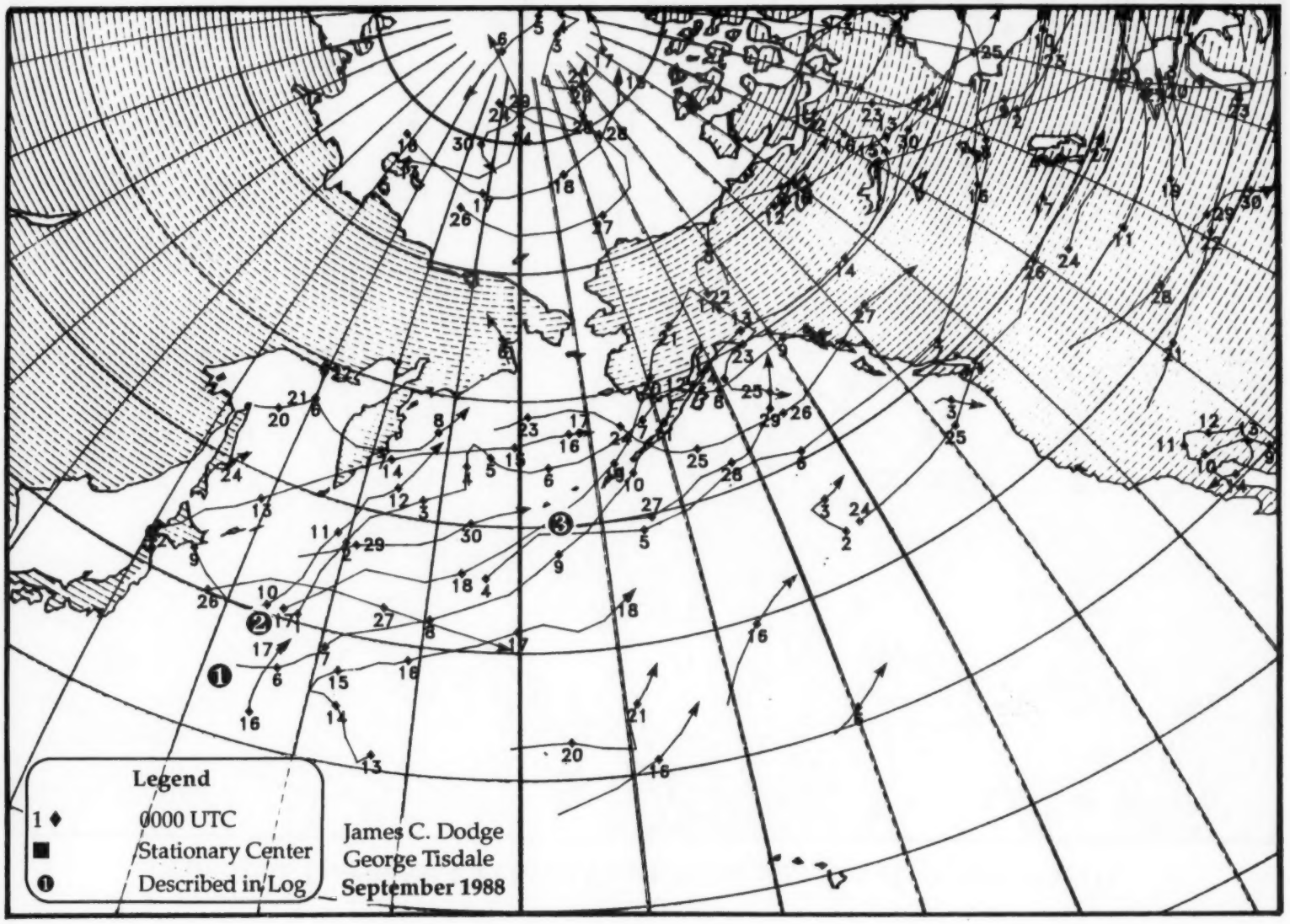
Principal Tracks of Cyclone Centers at Sea Level, North Pacific



Principal Tracks of Cyclone Centers at Sea Level, North Pacific



Principal Tracks of Cyclone Centers at Sea Level, North Pacific



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Vessel	Ship Call	Date	Position Lat deg	Position Lon deg	Time GMT	Wind Dir 10 deg	Wind Speed kn	Vsby n mi	Present Wx code	Pressure mb	Temp deg C Air	Temp deg C Sea	Sea Waves Pd sec	Sea Waves Hgt ft	Swell Waves Dir	Swell Waves Pd sec	Swell Waves Hgt ft
PACIFIC JULY																	
EVER GOLDEN	BKHL	12	44.7N	175.2E	06	05	M40	.25	41	1009.0	9.0	12.0	8	18	08	9	21
PRESIDENT HOOVER	WTST	31	37.6N	149.2E	12	21	M52	2	61	0992.0	22.2	24.5		7			26
ATLANTIC JULY																	
NEDLLOYD HUDSON	WPWH	24	46.4N	23.5W	06	20	42	1	52	1007.5	18.0		10	19.5	23	19	13
PACIFIC AUG.																	
EXXON NORTH SLOPE	KHLQ	21	41.7N	127.4W	00	01	M40	10	01	1017.5	22.8	16.1	9	21	01	9	21
ATLANTIC AUG. .																	
EXPORT CHAMPION	WLCG	7	37.8N	68.0W	18	16	50	5			25.0	30.1	18	37.5	05	XX	5
GR. LAKES SEP.																	
EDGAR B. SPEER	QZ9670	5	43.9N	86.8W	00	36	M40	5			16.0	18.0	8	21			
PACIFIC SEP.																	
SOLAR WING	3EKY6	2	34.0N	154.4E	12	19	M48	5	25	1003.5	25.0	27.0	8	16.5	36	15	19.5
HASSAN MERCHANT	3EPG2	10	40.7N	124.7W	21	35	M40	5		1014.1	15.0	11.0	8	19.5			
NATIONAL DIGNITY	DZRG	14	50.6N	176.8E	12	22	M40	.5	45	1008.0	11.0	9.0	9	19.5	22	10	23
NATIONAL DIGNITY	DZRG	14	50.5N	174.2E	18	25	M40	.5	45	1008.0	11.0	9.0	9	19.5	22	10	23
CURRENT	3FKA2	17	40.0 N	161.0 E	06	20	M42	1		0994.5	24.0	23.0	12	32.5			
SEALAND ENDURANCE	KGJX	17	38.4N	156.7 E	06	25	M42	5	02		25.0		7	21	25	9	21
OCEAN LUCKY	DZHK	18	48.6N	172.1W	18	25	M60	<50yd	61	0980.0	9.0	10.5	9	16.5	25	12	19.5
OCEAN STEELHEAD	H3YD	19	50.4 N	169.2 W	00	20	M50	.25	07	0979.0	9.0	9.0	8	14.5	20	10	19.5
SEALAND KODIAK	KGTZ	20	58.5 N	148.6 W	06	23	M45	5	21	0994.0	10.0	9.9	6	14.5	23	7	24.5
LOUIS MEARSK	OXMA2	27	43.0 N	168.1 W	00	26	M40			1001.0	14.8	14.0	6	19.5			
SEALAND ANCHORAGE	KGTX	27	55.7 N	143.5 W	18	11	M40	2	62	0992.0	10.0	10.3	5	18	11	6	19.5
SEALAND ANCHORAGE	KGTX	27	54.8 N	140.8 W	23	12	M40	5		0978.0	10.0	10.5	6	16.5	11	8	19.5
EVER GUARD	3ESL2	28	45.8 N	159.5 W	00	28	M42	5	01	0996.5	13.0	13.0	9	16.5	25	18	21
SANSINENA II	WSIN	28	57.8 N	141.4 W	06	09	M50	2	62	0983.5	7.8	11.1	8	26	09	9	29.5
EVER GUARD	3ESL2	29	44.5 N	149.8 W	00	27	M40	10	02	1005.0	17.0	15.0	8	16.5	25	18	19.5
MILLER FREEMAN	WTDM	29	49.4 N	134.4 W	00	18	M46	2		1000.0	17.2	13.0	7	6.5	18	8	19.5
ATLANTIC SEP.																	
NUEVO SAN JUAN	KEOD	9	27.7 N	87.1 W	16	16	45	2	17	1008.0	29.0	27.2	6	19.5	16	6	21
NUEVO SAN JUAN	KEOD	9	27.6 N	87.1 W	18	16	45	2	05	1007.5	28.0	28.3	6	28	16	6	28
NUEVO SAN JUAN	KEOD	9	27.4 N	86.9 W	21	18	50	5	15	1008.5	28.3	28.3	4	6.5	16	6	23
NUEVO SAN JUAN	KEOD	13	24.2 N	82.6 W	18	09	50	5	14	1009.5	29.4	28.3	6	23	09	6	26
TONSINA	KJDG	14	20.1 N	83.9 W	12	17	M 48	2	62		26.7	28.9	8	14.5	21	10	21
TONSINA	KJDG	14	20.6 N	84.2 W	15	15	M 42	2	82		25.0	28.9	9	16.5	16	10	23
USNS SEALIFT ATLC	NIKA	15	19.9 N	94.7 W	15	29	50	2	62	1001.0	27.0		6	11.5	29	7	19.5
USNS SEALIFT ATLC	NIKA	15	19.9 N	94.9 W	18	29	60	2	62	0999.8	26.0		5	11.5	28	7	19.5
USNS SEALIFT ATLC	NIKA	15	19.8 N	94.2 W	21	26	55	2	62		24.0		6	11.5	26	7	19.5
AMELIA TOPIC	5MRW	16	27.0 N	88.3 W	00	12	40			1011.0	28.0	30.0	12	19.5			
USNS SEALIFT ATLC	NIKA	16	19.9 N	93.2 W	03	20	45	5		1004.0	27.0		6	11.5	23	7	21
AMELIA TOPIC	5MRW	16	26.1 N	87.8 W	06	12	40			1013.0	27.0	30.0	12	19.5			
USNS SEALIFT ATLC	NIKA	16	20.4 N	93.0 W	06	22	50	2	62	1004.0	27.0		6	11.5	22	7	21

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Ship Name	radio	mail
1ST LT ALEX BONNYMAN	37	30
2ND LT. JOHN P. BOBO	8	
A. V. KASTNER	89	
ABBEY	154	
ACADIA FOREST	54	50
ACE ACCORD	105	180
ACE ENTERPRISE		60
ACHIEVER		27
ACT 11	40	
ACT 111	204	
ACT 5	190	
ACT 6	139	
ACT 7	187	
ACT 9	48	
ACT I	134	
ACT IV	98	
ADABELLE LYKES	37	138
ADDIRIYAH	25	
ADIAN MAERSK	14	36
ADMIRALTY BAY	50	146
ADONIS	55	91
AFRICAN FERN	38	
ALAIN LD	93	
ALASKA RAINBOW	33	136
ALBERT MAERSK	47	135
ALDEN W. CLAUSEN	5	23
ALEMANIA EXPRESS	81	
ALISON	2	
ALLIGATOR FORTUNE	31	91
ALLIGATOR GLORY	30	90
ALLIGATOR HOPE	47	71
ALLIGATOR LIBERTY	26	
ALLISON LYKES	5	7
ALMERIA LYKES	56	89
ALMUDENA	3	24
ALTAMONTE	31	46
ALVA MAERSK	32	
AMBASSADOR	46	118
AMBASSADOR BRIDGE	56	64
AMELIA TOPIC	15	151
AMERICA EXPRESS	47	
AMERICA SUN	1	
AMERICAN ALABAMA	29	112
AMERICAN CONDOR	12	
AMERICAN CORMORANT	14	
AMERICAN EAGLE	38	87
AMERICAN FALCON	2	44
AMERICAN KESTREL	24	53
AMERICAN MAINE	3	37
AMERICAN MARINER		11
AMERICAN NEW YORK	57	147
AMERICAN REPUBLIC		106
AMERICAN RESOLUTE	27	107
AMERICAN TROJAN	17	23
AMERICAN UTAH	51	147
AMERICAN VIRGINIA	42	137
AMERICANA	20	105
ANTHONY RAINBOW	51	144
AQUA CITY	96	171
AQUA GARDEN	46	114
AQUARIUS	50	136
ARCO ALASKA	30	53
ARCO ANCHORAGE	28	13
ARCO CALIFORNIA	23	48
ARCO FAIRBANKS	13	28
ARCO INDEPENDENCE	5	15
ARCO JUNEAU	22	46
ARCO PRUDHOE BAY	17	13
ARCO SAG RIVER	1	17
ARCO SPIRIT	20	13
ARCO TEXAS	18	48
ARCTIC TOKYO	28	205
ARGONAUT	16	55
ARILD MAERSK	101	177
ARION	15	
ARIOSTO AMADO	71	
ARMCO	109	270
ARNOLD MAERSK	47	160
ARTHUR M. ANDERSON	155	112
ASHLEY LYKES	21	
ASIAN VENTURE	23	9
ASPEN	13	43
ASTERIKS	61	94
ASTORIA	18	
ATIGUN PASS	103	292
ATLA	13	22
ATLANTIC	45	75
ATLANTIC ANGEL	8	6
ATLANTIC CARTIER	28	
ATLANTIC COMPANION	63	
ATLANTIC CONVEYOR	96	
ATLANTIC RAINBOW	32	62
ATLANTIC SPIRIT	18	98
AURORA ACE	83	
AUSTANGER	16	53
AUSTRAL RAINBOW	29	46
B.T. ALASKA	51	65
B.T. SAN DIEGO	48	269
BAAB ULLAH	8	
BACTAZAR	45	52
BALTIMORE TRADER	44	98
BANGLAR KALLOL		71
BAR' ZAN	48	69
BARBER HECTOR	102	
BARBER PERSEUS	45	
BARBER TAMPA	9	
BARBER TOBA	9	
BARRYDALE	66	
BAY BRIDGE	69	
BAYAMON	59	132
BCR KING	133	
BEACON	4	
BEAUTEOUS	20	3
BELLE RIVER		378
BENSON FORD		157
BHAVABHUTI	7	
BIBI	130	
BISLIG BAY	72	
BLUE HAWK	61	
BOGASARI DUA	21	71
BOGASARI LIMA	40	35
BOLIVAR	27	115
BRIGIT MAERSK	72	146
BRILLIANT ACE	62	
BROOKLYN	15	
BROOKLYN BRIDGE	212	
BROOKS RANGE	28	30
BUNGA KENANGA	1	
BUNGA KESIDANG	22	35
BUNGA MELAWIS	3	7
BURNS HARBOR		202
CAGUAS	24	
CALANUS		21
CALCITE II	104	138
CANADIAN RAINBOW	14	172
CAPE BYRON	55	
CAPE HATTERAS	90	
CAPE ROGER	83	
CAPE YORK	172	
CAPRICORN	38	54
CARIBE 1	13	57
CARLA A. HILLS	5	79
CARMEN	2	
CASON J. CALLAWAY	76	109
CECILIE MAERSK	11	29
CELEBRATION	1	109
CGM LORRAINE	8	
CHACO	53	
CHARLES M. BEEGHLEY	72	161
CHARLES PIGOTT		28
CHARLOTTE LYKES	88	125
CHELSEA	18	42
CHEMICAL PIONEER	47	82
CHERRY VALLEY	21	84
CHESAPEAKE BAY	19	159
CHESAPEAKE TRADER	22	40
CHESNUT HILL	28	48
CHEVRON ANTWERP	14	136
CHEVRON ARIZONA	42	91
CHEVRON BURNABY	34	
CHEVRON CALIFORNIA	112	176
CHEVRON COLORADO	24	88
CHEVRON COPENHAGEN		206
CHEVRON EDINBURGH	27	117
CHEVRON EQUATOR	42	187
CHEVRON LONDON	6	356
CHEVRON LOUISIANA	8	9
CHEVRON METEOR	42	117
CHEVRON MISSISSIPPI	102	161
CHEVRON NAGASAKI		167
CHEVRON OREGON	51	119
CHEVRON PACIFIC	69	107
CHEVRON PERTH	18	107
CHEVRON SKY		212
CHEVRON STAR	2	
CHEVRON SUN		105
CHIA FU	8	
CHICKASAW	15	
CHILBAR	4	11
CHRISTINA	80	
CITADEL HILL	124	
CITY OF MIDLAND	66	277
CLARENCE	24	
CLEMENT	89	
CLEMENTINA	5	
CO-OP EXPRESS I	17	
CO-OP EXPRESS II	104	
COAST RANGE	8	32
COASTAL MANATEE	21	
COLIMA	36	36
COLUMBIA STAR		52
COLUMBUS AMERICA	336	
COLUMBUS AUSTRALIA	54	
COLUMBUS ISELIN		28
COLUMBUS LOUISANA	98	
COLUMBUS NEW ZEALAND	53	
COLUMBUS OHIO	18	
COLUMBUS VICTORIA	91	
COLUMBUS VIRGINIA	95	
COLUMBUS WELLINGTON	142	
CONCERT EXPRESS	71	
CONCHO	20	
CONTENDER ARGENT	12	
CORAH ANN		34
CORNUCOPIA	46	161
CORONADO	26	87
COURTNEY BURTON	132	189
CPL. LOUIS J. HAUGE JR	9	6
CRUSADER VENTURE	1	
CSS HUDSON	114	
CUENCA		56
CURRENT	66	79
CYGNUS	62	198
D.L. BOWER		140
DA MOSTO	28	54
DALAMAN	9	
DAWN	36	47

Ship Name	radio	mail
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DELAWARE TRADER	73	108
DIANA	4	25
DILIGENCE TRADER		129
DOCK EXPRESS TEXAS	10	228
DON PAZ II	1	
DREDGE WHEELER	1	
DUBHE	12	
DUSSELDORF EXPRESS	54	
E.R. BRUSSEL	53	136
EASTERN FRIENDSHIP	30	42
EASTERN GLORY	21	
EASTERN VENTURE	11	65
EDGAR B. SPEER		133
EDGAR M. QUEENY	56	105
EDWARD L. RYERSON	57	203
EDWIN H. GOTT		149
ELBE MARU	84	
ELIZABETH LYKES	21	62
EMERALD SEA	89	100
EMPIRE STATE	7	15
ENDEAVOR	67	116
ENSOR	26	132
EUPEN	14	
EVER GAINING	9	17
EVER GARDEN	8	
EVER GATHER	10	22
EVER GENIUS	9	12
EVER GENTLE	8	
EVER GIANT	67	102
EVER GIFTED	4	
EVER GIVEN		9
EVER GLAMOUR		11
EVER GLEAMY	13	7
EVER GLOBE	13	9
EVER GLORY	14	
EVER GOING	1	
EVER GOLDEN	19	27
EVER GOVERN		7
EVER GRACE	35	37
EVER GRADE	3	
EVER GROUP	10	15
EVER GROWTH	3	37
EVER GUARD	16	32
EVER GUIDE	14	24
EVER LINKING	42	45
EVER OASIS		57
EVER ORDER	19	22
EVER SUPERB	6	
EVER VALOR	68	176
EVER VALUE	1	
EVER VITAL	16	58
EXPORT CHAMPION	21	41
EXPORT FREEDOM	38	109
EXPORT PATRIOT	22	97
EXXON BALTIMORE	15	28
EXXON BATON ROUGE	3	44
EXXON BAYTOWN	7	12
EXXON BENICIA	9	13
EXXON BOSTON	17	65
EXXON HOUSTON	12	11
EXXON JAMESTOWN	3	1
EXXON LEXINGTON	10	17
EXXON LONG BEACH	4	
EXXON NEW ORLEANS	3	3
EXXON NORTH SLOPE	28	37
EXXON PHILADELPHIA	25	52
EXXON PRINCETON		10
EXXON SAN FRANCISCO	8	11
EXXON VALDEZ	16	25
EXXON YORKTOWN	21	44
FALCON LEADER	93	80
FALSTAFF	3	
FARNELLA	211	
FERNCROFT	76	134
FESTIVALE	1	
FINNROSE	36	140
FLORIDA RAINBOW	45	86
FORTALEZA	38	171
FRANCIS SINCERE NO. 6	17	
FRED R.WHITE		36
FREDERICKSBURG	4	
FREEZER LYNX	45	44
FROTASIRIUS	30	
GALVESTON BAY	29	129
GEMINI	51	67
GENERAL HIZON	3	
GENERAL M.BELGRANDO	1	
GENERAL ROXAS	18	24
GENEVIEVE LYKES	9	27
GEORGE A. SLOAN	128	170
GEORGE A. STINSON		263
GEORGE H. WEYERHAEUSER	24	59
GEORGE WASHINGTON BRID	199	
GEORGIA		35
GERONIMO		4
GLACIER BAY	27	96
GLORIA	12	32
GLORIOUS SPICA	73	
GLORY FIELD	52	
GOLAR PETROSUN	1	22
GOLDEN APO	45	14
GOLDEN BLISS	16	
GOLDEN ENDEAVOR	20	
GOLDEN GATE	19	86
GOLDEN GATE BRIDGE	208	74
GOLDEN HAWK	91	142
GRAIGLAS	236	
GREAT LAND	286	
GREEN ANGELES	5	43
GREEN BAY	85	226
GREEN HARBOUR	43	12
GREEN HAWK	21	80
GREEN LAKE	109	81
GREEN MASTER	61	82
GREEN MAYA	31	49
GREEN RAINIER	32	95
GREEN SAIKAI	21	47
GREEN STAR	19	82
GREEN VALLEY	47	28
GREEN WAVE	14	
GREEN WOOD		11
GUANAJUATO	89	163
GUARDSMAN		174
GULF IDEAL	25	3
GYPSUM BARON	173	
GYPSUM COUNTESS	36	
GYPSUM KING	211	
HAI JUNG	21	
HAMANASU	1	
HANEI PEARL	31	
HANEI SUN	13	14
HANJIN BUSAN	5	43
HANJIN HONG KONG	36	40
HANJIN KEELUNG	25	
HANJIN KOBE	27	
HANJIN KUNSAN	45	34
HANJIN LONG BEACH	6	
HANJIN NEW YORK		18
HANJIN POHANG	31	13
HANJIN SAVANNAH	27	30
HANJIN SEOUL	39	53
HANJIN YOKOHAMA	4	5
HANSA BERGEN	37	
HARMAC DAWN	66	
HASSAN MERCHANT	158	155
HAWAIIAN RAINBOW	37	46
HAWTHORN HILL	18	81
HEERENGRASHT	104	
HEIDE	56	
HENRY FORD II		79
HENRY HUDSON BRIDGE	203	
HERMENIA	33	
HIRA #2	93	174
HIYOSHI MARU	56	
HOEGH CAIRN	14	17
HOEGH CLIPPER	7	9
HOEGH DENE	13	103
HOEGH DRAKE	21	
HOEGH DYKE	30	61
HOEGH MALLARD	5	
HOEGH MINERVA	30	51
HOHSING ARROW	1	
HOHSING BREEZE	29	
HOJIN MARU	75	
HOLIDAY	35	114
HOLSTEN TRADER	79	107
HONOLULU	133	
HRELJIN	42	
HUAL ROLITA	9	
HUAL TRANSPORTER	43	104
HUMBER ARM	30	31
HYUGA MARU	97	
HYUNDAI #203	3	
HYUNDAI #206	41	
HYUNDAI CHALLENGER	70	62
HYUNDAI COMMANDER	42	11
HYUNDAI E PLORER	13	38
HYUNDAI INNOVATOR		6
HYUNDAI PIONEER	35	60
IBIS ARROW	74	100
INCOTRANS PACIFIC	136	
INFANTA	105	
INGER	51	232
IRMA M	153	
IRVING L. CLYMER	41	51
ISLA BARTOLOME	5	
ISLAND PRINCESS	66	
ITALICA	22	94
ITAPE	33	
ITB PHILADELPHIA	15	160
J.A.W. IGLEHART		94
J.L. MAUTHE	32	54
JALISCO	19	130
JAMES LYKES	30	104
JAMES R. BARKER		65
JAPAN ALLIANCE	91	60
JAPAN APOLLO	111	91
JAPAN STORK	53	89
JAY LAXMI	1	
JEAN LYKES	44	73
JEBEL ALI	36	51
JO BIRK	61	
JO CLIPPER	83	
JO CYPRESS	50	
JO GRAN	60	131
JO LONN	139	
JO OAK	21	
JOHN G. MUNSON	116	111
JOHN LYKES	26	33
JOSEPH H. FRANTZ	71	45
JOSEPH L. BLOCK		5
JOSEPH LYKES	27	75
JOVIAN LILY	37	16
JUBILEE	1	
JULIUS HAMMER	1	149
KAHAROA	5	
KALAYAAN	25	
KALIDAS	35	
KASINA	41	22
KAUAI	69	194
KEE LUNG	13	62
KEISHO MARU	46	102
KENAI	13	
KENNETH E. HILL	1	5
KENNETH T. DERR	28	48
KENT	55	157
KENTUCKY HIGHWAY	38	
KEYSTONE CANYON	13	87
KEYSTONER	36	195
KIILSA	9	32
KISO	144	
KITTANNING	7	19
KOLN EXPRESS	45	

Ship Name	radio	mail
KOPER EXPRESS	16	
KOREAN WONIS JIN	16	
KOREAN WONIS ONE	41	39
KOREAN WONIS SEVEN	39	41
KOREAN WONIS SUN	22	1
KORYU MARU	18	
KUROBE	106	
LA PAMPA	9	
LANAI	1	
LARS MAERSK	26	53
LASH ATLANTICO	16	29
LAURA MAERSK	35	100
LAUST MAERSK	29	101
LAWRENCE A. GIANELLA	60	95
LEDA MAERSK	34	117
LEISE MAERSK	8	60
LERMA	132	
LESLIE LYKES	6	63
LETITIA LYKES	59	117
LEWIS WILSON FOY		406
LEXA MAERSK	29	62
LIBERTADOR GRAL SAN MA	2	
LIBERTY SUN	32	133
LIBERTY WAVE	32	13
LICA MAERSK	31	72
LICA MEARSK	7	25
LING LEO	12	202
LIONS GATE BRIDGE	30	135
LLOTD ITAJAI	76	
LLOYD MARANHAO	45	114
LLOYD SAO PAULO	60	
LLOYD SERGIPA	17	
LLOYD VITORIA	13	
LNG TAURUS	5	150
LONG LINES	57	
LONGEVITY	1	
LOTUS ACE	122	
LOUIS MAERSK	22	76
LOUIS MEARSK	1	46
LOUISE LYKES	10	14
LOUISIANA BRIMSTONE	2	39
LT. ODYSSEY	20	27
LURLINE	29	139
LUZON	35	151
M. P. GRACE	78	68
M/V MARINE RELIANCE	25	146
MACKINAC BRIDGE	222	
MADAME BUTTERFLY	45	26
MAERSK CONSTELLATION	28	67
MAERSK TACOMA	2	
MAERSK TOKYO	1	
MAERSK WIND	42	45
MAJ SANDVED	99	105
MAJ SIF	61	124
MAJ STEPHEN W PLESS MP	14	7
MAKILING	19	37
MALLORY LYKES	25	38
MANGAL DESAI	15	
MANHATTAN BRIDGE	128	
MANINGNING	85	155
MANUKAI	47	139
MANULANI	58	109
MARATHA MAJESTY	67	197
MARCHEN MAERSK	31	100
MARGARET LYKES	62	137
MARIA TOPIC	24	12
MARIF	23	42
MARJORIE LYKES	45	
MASON LYKES	42	92
MATSONIA	57	216
MAUI	55	197
MAUNALEI	2	9
MAWASH TAPUK	8	
MC KINNEY MAERSK	29	89
MCKINNEY MAERSK	2	35
MEDALLION	156	230
MEDUSA CHALLENGER	33	138
MELBOURNE HIGHWAY	8	
MELGAR BAY	9	58
MELVILLE	10	20
MEONIA	59	123
MERAK EIGHTY	46	107
MERCANDIAN CONTINENT	13	6
MERCANDIAN NAUTIC	64	45
MERCANDIAN SUN II	69	194
MERIDA	35	114
MESABI MINER		181
MICHIGAN		20
MICHIGAN HIGHWAY	41	
MICRONESIAN COMMERCE	12	32
MICRONESIAN INDEPENDEN	76	205
MIDDLETOWN	113	195
MILTA		44
MINERAL HOBOKEN	1	
MING ENERGY	16	25
MING GLORY	15	
MING MOON	11	13
MING OCEAN	7	36
MING PLEASURE	3	6
MING SPRING	5	
MING STAR	1	20
MING SUN	1	
MOANA PACIFIC	257	281
MOBIL ARCTIC	17	139
MOBIL MERIDIAN	151	177
MOKU PAHU	13	17
MONSUN	48	197
MORMACSKY	21	93
MORMACSTAR	21	32
MORMACSUN	47	38
MOSEL EXPRESS	129	
MOUNT VERNON VICTORY		19
MYRON C. TAYLOR	114	140
NACIONAL SANTOS	3	
NADA II	30	135
NANCY LYKES	5	42
NATIONAL DIGNITY	34	89
NATIONAL HONOR	7	76
NATIONAL PRIDE	35	70
NAVIGATOR		57
NAVIOS ENTERPRISE	15	
NAVIOS UNIQUE	86	
NECHES	5	33
NEDLLOYD ELBE	103	
NEDLLOYD HUDSON	33	180
NEDLLOYD KATWIJK	165	
NEDLLOYD KEMBLA	66	
NEDLLOYD KINGSTON	68	
NEDLLOYD KYOTO	113	
NEDLLOYD ROCHESTER	119	
NEDLLOYD ROSARIO	125	
NEDLLOYD ROTTERDAM	44	
NEDLLOYD ROUEN	129	
NEPTUNE ACE	117	
NEPTUNE AMBER	122	103
NEPTUNE CORAL	82	72
NEPTUNE DIAMOND	148	
NEPTUNE GARNET	43	
NEPTUNE IVORY	73	
NEPTUNE JADE	70	
NEPTUNE PEARL	68	51
NEPTUNE TOURMALINE	21	
NEW HORIZON		188
NEW INDEPENDENCE	40	
NEW JERSEY MARU	26	
NEW NOBLE	30	73
NEW TURQUOISE	45	12
NICOLET	9	88
NOAA DAVID STARR JORDA	209	222
NOAA SHIP ALBATROSS IV	284	324
NOAA SHIP CHAPMAN	323	360
NOAA SHIP DAVIDSON	179	191
NOAA SHIP DELAWARE II	226	256
NOAA SHIP DISCOVERER O	434	297
NOAA SHIP FAIRWEATHER	154	187
NOAA SHIP FERREL	142	57
NOAA SHIP HECK 591	48	109
NOAA SHIP JOHN N COBB	44	55
NOAA SHIP MCARTHUR	405	180
NOAA SHIP MILLER FREEM	444	453
NOAA SHIP MT MITCHEL	444	492
NOAA SHIP OCEANOGRAPHE	261	497
NOAA SHIP OREGON II	402	292
NOAA SHIP RAINIER	192	133
NOAA SHIP RUDE 590	11	13
NOAA SHIP SURVEYOR	197	139
NOAA SHIP T. CROMWELL	480	543
NOAA SHIP WHITING	282	315
NORDHVAL	29	
NORWAY	14	
NOSAC E PRESS	4	103
NOSAC SEL	26	
NOSAC SKAUKAR	14	27
NOSAC SKY	32	56
NOSAC TAI SHAN	49	23
NOSAC TAKARA	4	
NOSAC TAKAYAMA	85	73
NOSAC TRIGGER	33	66
NOSIRA SHARON	105	
NOVA EAGLE	3	
NUEVO SAN JUAN		82
NURNBERG EXPRESS	86	
OAXACA	45	68
OCEAN BRIDGE	17	
OCEAN COMMANDER #1	41	8
OCEAN LUCKY	25	164
OCEAN STEELHEAD	38	96
OLEANDER	173	170
OLGA TOPIC	61	48
OLIVE ACE	4	
ORANGE BLOSSOM	60	198
ORANGE STAR	1	
ORCHID	71	73
ORCHID #2	28	27
OREGON RAINBOW II	47	109
ORIENTAL DIPLOMAT	31	
ORIENTAL EDUCATOR	164	195
ORIENTAL EXECUTIVE	63	219
ORIENTAL EXPLORER	56	257
ORIENTAL FAIR	55	51
ORIENTAL FAITH	46	
ORIENTAL FORTUNE	17	
ORIENTAL FREEDOM	144	
ORIENTAL FRIENDSHIP	40	146
ORIENTAL KNIGHT	2	
ORIENTAL MINISTER	30	
ORIENTAL PATRIOT	47	126
ORIENTAL PHOENIX		160
ORION HIGHWAY	16	
OVERSEAS CHICAGO	15	
OVERSEAS HARRIET	43	136
OVERSEAS JOYCE	42	119
OVERSEAS JUNEAU	17	105
OVERSEAS MARILYN	28	51
OVERSEAS OHIO	18	10
OVERSEAS VALDEZ		72
OVERSEAS VIVIAN	16	35
OVERSEAS WASHINGTON	56	108
PACDUCHESS	56	
PACDUKE	18	
PACEMPEROR	19	
PACGLORY	9	
PACIFIC ARROW	131	94
PACIFIC DAWN	14	
PACIFIC PRINCESS	64	
PACIFIC RAINBOW	42	
PACIFIC VENTURE	34	
PACIFIC VICTORY	18	28
PACIFIC WING	62	
PACKING	9	
PACMAJESTY	19	
PACMERCHANT	24	
PACMONARCH	7	
PACPRINCE	73	46

Ship Name	radio	mail
PACPRINCESS	8	
PAN FORTUNE	20	
PANCALDO		37
PATRIOT	41	
PAUL BUCK	117	50
PAUL THAYER		21
PAWNEE	1	
PECOS	14	50
PEGGY DOW	158	
PENNSYLANIA RAINBOW	52	63
PENNSYLVANIA TRADER	31	143
PETER W.ANDERSON		171
PETERSFIELD	115	
PFC EUGENE A. OBREGON	4	
PFC JAMES ANDERSON JR	11	47
PFC WILLIAM B. BAUGH	6	23
PHAROS	71	
PHILIP R. CLARKE	167	141
PHILIPPINE VICTORY	20	
PILAR		102
POCAHONTAS	4	
POLAR ALASKA	11	185
POLYNESIA	182	252
POMELLA	29	
PONCE	48	183
POQUITA MAMI	77	262
PORTLAND	89	150
POTOMAC TRADER	6	13
PRESIDENT ARTHUR	27	101
PRESIDENT BUCHANAN	56	71
PRESIDENT CLEVELAND	25	43
PRESIDENT EISENHOWER	157	182
PRESIDENT F. ROOSEVELT	85	107
PRESIDENT GARFIELD	75	241
PRESIDENT GRANT	66	118
PRESIDENT HARDING	80	188
PRESIDENT HARRISON	79	110
PRESIDENT HOOVER	57	133
PRESIDENT JEFFERSON	21	28
PRESIDENT KENNEDY	29	50
PRESIDENT LINCOLN	124	209
PRESIDENT MADISON	69	177
PRESIDENT MONROE	96	165
PRESIDENT PIERCE	8	
PRESIDENT TAYLOR	7	22
PRESIDENT TYLER	34	208
PRESIDENT VAN BUREN	38	100
PRESIDENT WASHINGTON	90	156
PRESIDENT WILSON	10	49
PRESQUE ISLE		207
PRIMORJE	59	
PRINCE OF TOKYO	90	187
PRINCE WILLIAM SOUND	19	42
PRINCESS DIAN	9	46
PROSPERIDAD	69	143
PUERTO RICO	53	173
PURITAN	187	
PVT HARRY FISHER	2	
QUEEN ELIZABETH 2	102	
QUEEN OPAL	27	20
RAINBOW BRIDGE	119	99
RAINBOW HOPE	105	94
RALEIGH BAY	38	115
RANGER	68	15
REGENT	4	19
REGINA MAERSK	33	75
RESERVE	81	221
RHINE FOREST		20
RICHARD G MATTIESEN	86	
RIJEKA EXPRESS	41	
RIMBA KERUING	10	40
RIO ESQUEL	30	21
RIO FRIO	32	
RIO GRANDE	2	
RIO LIMAY	10	
ROBERT CONRAD	170	56
ROBERT E. LEE	19	
ROGER BLOUGH		136
ROGER R. SIMONS	52	87
ROSINA TOPIC	16	136
ROTTERDAM	8	
ROVER		8
ROYAL PRINCESS	5	
ROYAL VIKING SEA	4	
ROYAL VIKING SKY	3	
RUTH LYKES	52	44
SAINT LAURENT	22	
SAM HOUSTON	17	
SAMOAN REEFER	66	193
SAMRAT ASHOK	15	
SAMU	4	
SAMUEL H. ARMACOST	1	
SAN JUAN	8	
SAN MARTIN I	96	
SAN MATEO VICTORY	21	91
SAN MIGUEL BAY	41	154
SANKO CORAL	10	
SANKO DIGNITY	16	
SANKO EAGLE	17	
SANKO HAWK	12	
SANKO PEACE	23	
SANKO SWALLOW	1	
SANSINENA II	31	88
SANTA ADELA	69	93
SANTA CRUZ II	34	17
SANTA JUANA	115	231
SANWA MARU	39	
SATURN DIAMOND	27	114
SAUDI DIRIYAH	21	
SAUDI RIYADH	26	
SAUDI TABUK	42	
SAVANNAH	86	
SCANDINAVIAN HIGHWAY	66	
SCARAB	36	89
SEA BELLS	14	62
SEA DIAMOND	57	129
SEA FAN	38	145
SEA FORTUNE	29	60
SEA FOX	9	102
SEA JADE	62	107
SEA LANTERN	54	61
SEA LIGHT	24	111
SEA LION	92	205
SEA TRADE	116	
SEA TRANSPORTER	61	
SEA WEALTH	8	
SEA WOLF	63	183
SEALAND ANCHORAGE	15	79
SEALAND ATLANTIC	42	111
SEALAND CHALLENGER	31	21
SEALAND COMMITMENT	46	154
SEALAND CRUSADER	49	49
SEALAND DEFENDER	41	166
SEALAND DEVELOPER	30	136
SEALAND DISCOVERY	67	195
SEALAND ENDURANCE	32	85
SEALAND ENTERPRISE	89	261
SEALAND EXPLORER	68	152
SEALAND EXPRESS	42	30
SEALAND FREEDOM	44	118
SEALAND INDEPENDENCE	118	324
SEALAND INNOVATOR	57	123
SEALAND KODIAK	36	99
SEALAND LIBERATOR	51	100
SEALAND MARINER	49	167
SEALAND NAVIGATOR	69	230
SEALAND PACIFIC	51	188
SEALAND PATRIOT	46	130
SEALAND PERFORMANCE	45	150
SEALAND PRODUCER	4	
SEALAND QUALITY	5	104
SEALAND TACOMA	31	130
SEALAND TRADER	109	180
SEALAND VOYAGER	27	125
SEALNES	22	121
SEAWARD BAY	11	
SEDCO/BP 471	132	105
SENATOR		121
SEVEN OCEAN	64	60
SGT WILLIAM A BUTTON	68	97
SGT. METEJ KOCAK	11	14
SHELDON LYKES	39	55
SHELLY BAY	2	
SHENANON	44	49
SHIN BEISHU MARU	56	
SHINKASHU MARU	64	
SIERRA MADRE	25	38
SILVER CLIPPER	15	
SILVER STAR	27	
SIOUX TATE	25	
SKANDERBORG	23	23
SKAUBORD	77	168
SKAUGRAN	118	
SKEENA	153	
SKRIM	179	
SOLAR	8	24
SOLAR WING	54	112
SONBAI	42	152
SONORA	51	
SOPHIA	45	
SOUTHLAND STAR	92	
SOUTHWARD	49	56
SPRING BEAR	107	
SPRING BIRD	18	14
SPRING SEAGULL	3	
SPRING SWIFT		11
SPRING VEGA	5	
ST EMILION	1	109
STAR EAGLE		5
STAR GEIRANGER	1	
STAR GRAN	78	135
STAR HONGKONG	66	
STAR OF TEXAS	5	
STELLA LYKES	71	158
STEWART J. CORT		218
STONEWALL JACKSON	10	8
STRATHCONON	133	
STREAM BUSUANGA	1	
STRIDER ISIS	48	79
STUTTGART EXPRESS	66	
SUE LYKES	39	123
SUGAR ISLANDER	40	53
SUN PRINCESS	15	
SUN SUMA	1	
SUN VIKING		24
SUNBELT DIXIE	151	206
SUNNY SUPERIOR	5	105
SWIFT TRADER	34	
SWIFTNES	31	60
SYOSSET	12	
TABASCO	26	111
TAI CORN	14	29
TARGET	11	37
TEXACO GEORGIA	21	
TFL FREEDOM	1	
THOMAS G. THOMPSON	175	113
THOMAS WASHINGTON	139	232
THOMPSON LYKES	14	
THOMPSON PASS		21
TOHBEI MARU	83	10
TOKYO MARU	69	
TOKYO RAINBOW	34	28
TOLUCA		24
TONCI TOPIC	11	83
TONSINA	40	159
TOWER BRIDGE	65	
TROPIC SUN	17	129
TROPICAL BEAUTY	7	25
TROPICALE	53	73
TULSIDAS	15	
ULTRAMAR	39	
ULTRASEA	21	
UNAMONTE	39	2
UNI MASTER	31	46

Ship Name	radio	mail
UNIVERSE	13	
USCGC ACTIVE WMEC 618	1	
USCGC ALERT (WMEC 630)	30	27
USCGC BASSWOOD (WLB 38	57	
USCGC BISCAYNE BAY	3	22
USCGC BLACKHAW (WLB 39	17	
USCGC BOUTWELL WHEC 71	108	
USCGC BRAMBLE (WLB 392	1	
USCGC BUTTONWOOD WLB 3	11	
USCGC CHEROKEE WMEC 16	12	
USCGC CITRUS (WMEC 300	43	
USCGC CLOVER (WMEC 292	73	
USCGC CONIFIR(WLB 301)	13	16
USCGC COURAGEOUS	66	5
USCGC DEPENDABLE	10	
USCGC EAGLE (WIX 327)	95	
USCGC ESCANABA	82	
USCGC ESCAPE (WMEC 6)		204
USCGC HARRIET LANE	6	
USCGC IRONWOOD (WLB 29	27	7
USCGC JARVIS (WHEC 725	39	53
USCGC KATMAI BAY	11	
USCGC MACKINAW	19	63
USCGC MALLOW (WLB 396)	26	
USCGC MESQUITE (WLB 30	6	36
USCGC MIDGETT (WHEC 72	10	
USCGC MORGENTHAU	40	
USCGC NEAH BAY	3	
USCGC NORTHLAND WMEC 9	44	
USCGC NORTHWIND WAGB 2	363	458
USCGC POLAR SEA WAGB 1	24	29
USCGC POLAR STAR WAGB	225	9
USCGC RESOLUTE WMEC 62	47	
USCGC RUSH (WHEC 723)		10
USCGC SEDGE (WLB 402)	32	65
USCGC SPENCER	10	
USCGC STEADFAST WMEC 6	81	
USCGC STORIS (WMEC 38)	4	11
USCGC SWEETBRIER WLB 4	15	17
USCGC TAHOMA	24	
USCGC TAMAROA (WMEC 16	12	
USCGC TAMPA WMEC 902	30	43
USCGC VALIANT (WMEC 62	8	
USCGC VENTUROUS WMEC 6	3	
USCGC VIGILANT WMEC 61	17	
USCGC WOODRUSH (WLB 40	5	
USCGC YOCONA (WMEC 168	102	235
USNCC T/V 47311		3
USNS ALGOL	38	74
USNS ALTAIR	11	
USNS BARTLETT(T-AGOR 1	116	70
USNS BELLATRIX	5	
USNS CATAWABA	25	
USNS CHAUVENET	27	
USNS DENEBOLA	28	
USNS GUS W. DARNELL	76	
USNS HARKNESS (T-AGS 3	1	
USNS JOHN LENTHAL		61
USNS JOSHUA HUMPREYS	33	
USNS KANE TAGS 27	20	
USNS KAWISHIWI	1	
USNS LYNCH T-AGOR 7	69	134
USNS MERCURY	57	73
USNS MISSISSINEWA		164
USNS MOHAWK (T-ATF 170	56	80
USNS NARRAGANSETT	116	210
USNS PAWCATUCK TAO-108		95
USNS POLLUX	11	
USNS POWHATAN TATF 166	27	40
USNS RANGE SENTINEL	1	
USNS REGULUS	5	
USNS SATURN T-AFS-10		138
USNS SEALIFT ANTARCTIC	60	138
USNS SEALIFT ARABIAN S	29	74
USNS SEALIFT ARCTIC	39	
USNS SEALIFT ATLANTIC	17	68
USNS SEALIFT CARIBBEAN	12	
USNS SEALIFT CHINA SEA	6	

Ship Name	radio	mail
USNS SEALIFT IND'N OCE	60	102
USNS SEALIFT MED	13	
USNS SEALIFT PACIFIC	34	56
USNS SIRIUS (T-AFS 8)		66
USNS SPICA (T-AFS 9)		29
USNS TRUCKEE (T-AO 147		17
USNS VANGUARD TAG 194	7	24
USNS WACCAMAW(TAO-109)		20
VALLEY FORGE	87	190
VAN HAWK	5	
VERRAZANO BRIDGE	94	78
VIRGO	23	153
VISHVA PAROG	24	
VISHVA PRAFULLA	1	23
VISHVA SHAKTI	4	
WASHINGTON HIGHWAY	164	67
WASHINGTON RAINBOW #2	12	121
WECOMA		233
WELLINGTON STAR	120	
WESER EXPRESS	2	
WESTWARD VENTURE	71	59
WESTWOOD ANNETTE	123	177
WESTWOOD BELINDA		21
WESTWOOD CLEO		48
WESTWOOD JAGO	119	37
WESTWOOD MARIANNE	30	35
WESTWOOD MERCHANT		96
WESTWOOD MERIT	7	41
WESTWOOD MUSKETEER	31	109
WILFRED SYKES	36	85
WILLIAM J. DELANCEY		397
WILLIAM R. ROESCH		116
WINTER MOON	9	
WINTER STAR	32	69
WINTER SUN	44	
WINTER WATER	18	28
WOLVERINE		78
WORLD WING #2	84	
YACU WASI	8	36
YAMASHIN MARU	33	
YAMATAKA MARU	48	
YORKTOWN SEA	7	18
YOUNG SCOPE	81	
YOUNG SOLDIER	22	
YOUNG SPROUT	68	140
YOUNG SWIFT	44	65
YS ARGOSY	29	76
ZAPATA ARCTIC	8	
ZEELANDIA	100	
ZEUS	5	
ZIM GENOVA	42	
ZIM HAIFA	61	
ZIM HONGKONG	39	
ZIM IBERIA	40	
ZIM KEELUNG	34	
ZIM LIVORNO	1	
ZIM MARSEILLES	19	
ZIM MIAMI	16	
ZIM NEW YORK	57	
ZIM SAVANNAH	23	
ZIM TOKYO	22	
ZOELLA LYKES	1	
9V3299		115
EBLM9		40
ELF7		74
KNES		13
WE3952		93
XCOX		10
ZSTG	1	
ZSUY	167	
ZSXN	2	
ZSZS	3	
ZSZW	162	
ZSZW02	1	
ZSZW03	1	
ZTBI	74	
ZTFEA	1	
ZTIP	1	

Ship Name	radio	mail
ZTJ	1	
ZTLM	1	
ZTMA	1	
ZTMC	1	
ZTMR	145	
ZTOI	1	
ZTR	1	
ZTSG	136	
ZTVR	1	
ZU	1	
ZUAB	119	
ZUAE	1	
ZUBR	34	
ZUBYK	1	
ZUOAF	1	
ZUPF	1	
ZURUJ	1	
ZUYAJ	1	
ZUYCN	1	
ZUZDW	1	
ZVHD	1	
ZVJ	1	
ZVKX	1	
ZVPBR	1	
ZVTL	1	
ZVUTTY	1	
ZWI	1	
ZWSC	1	
ZWW	1	
ZWY	1	
ZWZU	1	
ZYFP	1	
ZYJN	1	
ZZLP	1	

SUMMARY: GRAND TOTAL VIA RADIO 49292

GRAND TOTAL VIA MAIL 63755

TOTAL UNIQUE OBS 88617

TOTAL DUPLICATES 24430 (27.6%)

UNIQUE RADIO OBS.24862 (28.1%)

UNIQUE MAIL OBS. 39325 (44.4%)

Top Ships

Radio	Mail
T. Cromwell	T. Cromwell
Great Land	Lewis Wilson
	Foy

July, August and September 1988

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
A3BG	2	2	0	***
A3B2	36	36	0	***
A8VI	56	56	0	PACDUCHESS
CBMD	12	12	0	***
CBUN	11	11	0	VINA DEL MAR
CGBS	140	0	140	PARIZEAU
CGBU	195	0	195	DAWSON
CGBY	52	52	0	***
CGDG	31	31	0	HUDSON
CGDU	45	45	0	W. TEMPLEMAN
CG2683	14	14	0	ALFRED NEEDLER
CG2959	1	1	0	LEONARD J. COWLEY
CG2965	43	0	43	RICKER
CXFH	62	62	0	PRESIDENTE RIVERA
C7C	242	3	239	OCEAN STATION CHARLIE
C7L	114	114	0	OCEAN STATION LIMA
DAKE	126	126	0	KOELN ATLANTIC
DBBX	187	183	4	GAUSS
DEGRA	11	11	0	***
DGLM	62	62	0	MONTE ROSA
DGSR	59	59	0	COLUMBUS CANADA
DGUK	40	40	0	COLUMBUS VICTORIA
DGZU	2	2	0	***
DGZU	45	45	0	COLUMBUS VIRGINIA
DHCU	56	56	0	COLUMBUS WELLINGTON
DHJU	77	77	0	ACT 9
DHOU	81	81	0	PURITAN
DLEZ	30	30	0	YANKEE CLIPPER
DSCU	1	1	0	***
DSMD	65	65	0	SAINT LUCIA
DSNE	7	7	0	MT CABRITE
DSNZ	64	64	0	POLYNESIA
ELBX3	7	7	0	PACKING
ELDM8	79	79	0	SEAL ISLAND
ELDW8	70	70	0	SKRIN
ELED8	13	13	0	PACPRINCESS
EREA	26	21	5	MUSSOM
EREC	24	1	23	PRILIV
EREH	105	0	105	PRIBOY
EREI	155	8	147	OKEAN
ERES	79	58	21	VICTOR BUGAEN
ERET	79	78	1	GEORGE OUSHAKOV
EREU	30	29	1	ERNST KRENKEL
ESGG	87	11	76	VYACHESLAV FROLOV
FAUB	1	1	0	***
FMGB	4	4	0	MARION DUFRESNE
FNGS	55	55	0	LA FAYETTE
FNJT	27	27	0	KORRIGAN
FNOM	36	36	0	ANGO
FNPA	33	33	0	RONSARD
FNQB	16	16	0	ILE MAURICE
FNQC	20	20	0	VILLE DE ROUEN
FNQM	41	41	0	VILLE DE MARSEILLE
FNZP	9	9	0	RACINE
FNZQ	8	8	0	***
GACA	24	24	0	***
GHAM	5	5	0	CIROLANA
GOUL	39	39	0	ACT4
GOUN	28	28	0	ACT6
GPHH	62	62	0	FARNELLA
GXYY	28	28	0	AUSTRALIA STAR
GYAW	22	22	0	ENCOUNTER BAY
GYSE	8	8	0	BOTANY BAY
GZKA	39	39	0	ACT3
HCGT	3	3	0	BUCCANEER
HPAN	16	16	0	MICRONESIAN COMMERCE
HPEW	62	62	0	PACIFIC ISLANDER
H8DV	63	63	0	CAP ANAMUR
H9BQ	38	38	0	MICRONESIAN INDEPENDANCE
JASQ	2	2	0	HIYOSHI MARU
JBES	1	1	0	YAMASHIN MARU
JBOA	17	17	0	KEIFU MARU
JBRR	26	26	0	JAPAN TUNA II
JCCX	68	68	0	CHOFU MARU
JCDF	59	59	0	SOYO MARU
JCDT	44	44	0	AMERICA MARU
JCIN	34	34	0	TOKYO MARU
JCOD	10	10	0	SHOYO
JDWX	25	25	0	***
JFCI	55	55	0	***
JFDG	114	114	0	SHUNPU MARU
JGDW	10	10	0	KEITEN MARU
JGZK	63	63	0	RYOFU MARU
JJZC	24	24	0	HAKONE MARU
JHVF	10	10	0	KAIYO MARU
JPJX	60	60	0	HAKURYU MARU
JPVB	103	103	0	SEIFU MARU
JQVW	29	29	0	HIDAKA MARU
KGWT	19	19	0	THOMPSON,T.G.
KGWU	45	45	0	TH. WASHINGTON
KIAH	16	16	0	SEA LAND T.
KIVO	18	18	0	EXXON JAMESTOWN
KNBD	1	1	0	DELAWARE II
NAQD	29	29	0	JARVIS
NBMO	21	21	0	***
NBTM	11	11	0	POLAR STAR
NDWA	12	12	0	MORGENTHAU
NFKQ	6	6	0	SEALIFT ARABIAN SEA
NHNC	7	7	0	H. LANE
NIKA	61	61	0	SEALIFT ATLANTIC
NIKL	9	9	0	TAMPA
NLVS	1	1	0	RUSH
NOCF	119	119	0	***
NQST	79	79	0	SEALIFT ARCTIC
NRCB	19	19	0	EAGLE
NRFJ	103	103	0	NORTHWIND
OUEK	21	21	0	***
OUEQ	27	27	0	MC KINNEY MAERSK
OXFB	19	19	0	LEXA MAERSK
OXND	25	25	0	LARS MAERSK
OXVL	9	9	0	BAMSA DAN
PACM	26	26	0	PACIFIC MISSILE RANGE
PGDF	49	49	0	NEDLLOYD KATWYK
PGDG	29	29	0	NEDLLOYD KINGSTON
PGDS	42	42	0	NEDLLOYD KYOTO
PGOF	42	42	0	NEDLLOYD KEMBLA
PJVG	38	38	0	OLEANDER
PLAT	114	114	0	PLATFORM
SHIP	447	447	0	***
TEST	1	1	0	***
TFEA	12	12	0	BJARNI SAEMUNDSSON
TFJA	75	75	0	ARNI FRIDRIKSSON
UBNZ	112	112	0	SHULEYKIN AKADEMIK

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
UEAK	41	0	41	VALERIAN URVUAVEV
UFJM	55	26	29	***
UFVM	20	2	18	KAPITAN SHAYTANOV
UHQS	119	1	118	AKADEMIK KOROLEV
UJFO	45	45	0	MULTANOVSKIY PROF
UMAV	146	3	143	AKADEMIK SHIRSHOV
UMFW	75	75	0	PROF. ZUBOV
UMWZ	2	2	0	MIAMY
UNAC	1	0	1	SHOKALSKEY
UPUI	65	65	0	PROFESSOR VIZE
UQHM	52	5	47	ABAKANLES
UQXM	1	0	1	***
URVM	13	0	13	RUDOLF SAMOILOVICH
UUPB	22	6	16	AKADEMIK M. SHOKALSKIY
UUQR	17	17	0	MOLCHANOV PAVEL PRO
UVMJ	1	1	0	VSEVOLOD BERYOZKIN
UWEC	60	5	55	PROFESSOR KHROMOV
UZGH	102	97	5	PASSAT
VCBT	9	9	0	CAPE ROGER
VCTF	28	28	0	CAPE BRIER
VC9450	221	221	0	GADUS ATLANTICA
VJBQ	23	23	0	AHRO AUSTRALIA
VKCK	87	87	0	STUART
VKCU	6	6	0	DERWENT
VKDA	39	39	0	DARWIN
VKLC	91	91	0	BRISBANE
VKMK	6	6	0	***
VKMM	41	41	0	TEALE
VKMS	50	50	0	COOK
VLMB	120	120	0	TORRENS
VMAP	174	174	0	AUSTRALIAN PROGRESS
VPGE	37	37	0	SWAN REEFER
VXMB	53	53	0	AIRCRAFT
WA2II	56	56	0	ALASKA
WCGM	20	20	0	CHEVRON CALIFORNIA
WECB	19	19	0	MELVILLE
WHBA	11	11	0	R.D.CONRAD
WMVC	18	18	0	J.N.COBB
WMVF	158	158	0	ALBATROSS IV

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
WRA4560	14	14	0	BOLD VENTURE
WRBA	4	4	0	***
WRBB	4	4	0	***
WSE3385	87	87	0	GLORITA
WTDF	45	45	0	T. CROMWELL
WTDK	235	235	0	D.S. JORDAN
WTDM	115	115	0	M.FREEMAN
WTDO	160	160	0	OREGON II
WTEA	73	73	0	DISCOVERER
WTEB	1	1	0	FAIRWEATHER
WTED	183	183	0	CHAPMAN
WTEF	8	8	0	RAINIER
WTEG	171	171	0	MOUNT MITCHELL
WTEJ	181	181	0	MCARTHUR
WTEK	16	16	0	DAVIDSON
WTEP	381	381	0	OCEANOGRAPHER
WTES	54	54	0	SURVEYOR
WTEW	112	112	0	WHITING
WXAQ	2	2	0	***
WXBR	38	38	0	CHEVRON MISSISSIPPI
WXQ7334	9	9	0	PETER ANDERSON
WYA4481	44	44	0	W.J. DELANCEY
WYU6568	25	25	0	DEFIANCE
ZCSK	73	73	0	SKEENA
ZCSL	28	28	0	MIMOS
ZMFS	1	1	0	***
ZM7552	1	1	0	KAHA ROA
3ECT5	1	1	0	SHEARWATER
3E1R2	12	12	0	PRESIDENTE IBANEZ
3E2G5	10	10	0	HIKAWA II
3FHI2	73	73	0	MOANA PACIFIC
5MCB	7	7	0	PACMERCHANT
7JOB	26	26	0	SHINKASHU MARU
7KOD	20	20	0	YOKO MARU
9UUU	6	6	0	AHRO ASIA

TOTAL BATHYS RECEIVED 8665
TOTAL TESACS RECEIVED 1487
TOTAL REPORTS RECEIVED 10152

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July, August and September 1988

Wave observations are taken hourly. The significant wave height (H 1/3) is equivalent to the average height of the highest one–third of the waves during the 20–minute averaging period (sampling frequency is .67 sec). The maximum significant wave height is the highest of these values. The maximum wind speed and direction are based upon an 8.5–minute averaging period each hour. The air temperature is sampled for 90 seconds while the water temperature is sampled for 1 second.

JULY 1988

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
32302	18.0S	085.1W	741	17.9	19.1	2.4	4.4	17/13	12.4	SE	25.1	19/15	1019.0
41002	32.2N	075.3W	741	26.1	26.5	1.1	1.9	22/08	10.4	S	22.1	01/14	1020.3
41006	29.3N	077.4W	429	27.6	28.1	1.0	1.4	19/20	8.3	SE	17.9	20/16	1021.3
41008	30.7N	081.1W	740	26.5	27.1	0.9	2.3	06/02	9.8	S	28.2	01/00	1018.9
42001	25.9N	089.7W	741	28.3	29.2	0.6	2.2	08/00	0.0	N			1017.6
42002	26.0N	093.5W	742	28.3	29.2	0.6	1.7	15/10	7.8	SE	18.7	15/07	1016.9
42003	25.9N	085.9W	743	28.1	29.2	0.5	2.9	07/11	7.5	E	23.7	07/11	1018.0
42007	30.1N	088.9W	742	27.6	27.4	0.3	1.3	07/20	9.3	SW	23.9	04/02	1018.2
42015	30.1N	088.2W	742	27.6	28.5	0.4	1.5	07/17	8.5	SW	22.3	05/23	1017.7
42016	30.2N	088.1W	742	27.5	28.2	0.3	1.1	07/12	8.7	SW	23.5	05/23	1017.5
44004	38.5N	070.6W	743	23.5	23.3	1.2	2.8	13/13	1.5	N	16.5	28/12	1018.6
44005	42.7N	068.6W	743	17.7	16.3	1.0	2.1	17/07	9.0	SW	21.1	14/23	1016.7
44007	43.5N	070.1W	741	17.5	15.6	0.6	2.2	14/23	7.3	S	25.3	14/20	1014.6
44008	40.5N	069.5W	740	19.1	16.0	1.1	2.6	23/18	10.0	S	21.0	21/23	1016.8
44009	38.5N	074.6W	732	21.7	20.8	0.8	1.6	22/05	11.4	SW	24.9	21/12	1016.5
44011	41.1N	066.6W	741	17.9	16.9	1.3	2.3	03/00	7.8	SW	19.9	18/12	1017.9
44013	42.4N	070.8W	743	19.6	16.1	0.3	0.7	01/00	0.0	N			1015.5
45001	47.6N	087.1W	743	12.0	8.0	0.2	1.0	13/18	8.4	S	18.7	15/15	1016.4
45002	45.3N	086.4W	742	17.9	16.9	0.3	2.1	15/21	7.6	SW	29.3	15/20	1016.0
45003	45.3N	082.8W	742	17.9	16.6	0.2	1.4	30/01	6.9	NW	21.6	30/00	1015.9
45004	47.6N	086.5W	741	9.7	7.0	0.2	1.2	15/22	6.5	S	18.3	15/15	1015.3
45005	41.7N	082.4W	741	23.7	24.0	0.2	1.2	01/00	7.3	SW	31.5	11/02	1016.2
45006	47.3N	089.9W	743	14.6	11.9	0.2	1.3	15/15	5.8	S	22.9	30/00	1015.2
45007	42.7N	087.1W	741	21.8	21.3	0.4	1.4	01/05	7.5	N	21.4	15/22	1016.2
45008	44.3N	082.4W	214	20.6	19.8	0.3	1.6	31/07	6.0	SW	20.0	31/05	1016.5
46001	56.3N	148.3W	743	11.2	12.1	1.3	3.3	28/06	8.5	E	23.3	28/09	1014.8
46002	42.5N	130.4W	076	13.3	14.0				9.0	NW	15.0	01/21	1020.5
46003	51.9N	155.9W	740	9.3	8.5	1.6	4.1	28/07	12.7	W	28.8	27/03	1015.3
46005	46.1N	131.0W	743	13.4	14.1	1.3	2.4	24/19	8.4	NW	18.4	31/14	1022.8
46011	34.9N	120.9W	736	14.0	14.8	1.4	3.0	01/00	8.8	NW	25.3	16/00	1015.5
46012	37.4N	122.7W	738	12.3	13.5	1.5	3.4	01/07	6.5	NW	17.5	16/00	1015.7
46013	38.2N	123.3W	743	12.1	10.8	1.6	3.5	01/05	14.9	NW	34.5	01/03	1014.9
46014	39.2N	124.0W	742	12.2	11.2	1.8	3.4	10/00	11.4	N	28.9	17/02	1015.1
46022	40.7N	124.5W	741	12.3	11.7	1.7	3.7	18/05	9.1	N	22.8	09/12	1017.9
46023	34.3N	120.7W	742	14.8	15.5	1.6	3.0	16/05	12.3	NW	27.7	15/10	1014.6
46025	33.7N	119.1W	743	18.1	19.9	0.8	1.3	01/06	5.2	W	15.9	06/02	1014.2
46026	37.8N	122.7W	743	12.5	12.8	1.2	2.6	01/06	10.0	W	26.2	01/02	1014.9
46027	41.8N	124.4W	715	11.6	9.9	1.5	3.5	23/03	9.9	N	35.0	17/23	1018.0
46028	35.8N	121.9W	741	13.8	13.8	1.5	2.9	01/11	11.2	NW	25.9	14/23	1015.3
46030	40.4N	124.5W	742	11.2	9.5	1.7	3.6	18/05	11.4	N	23.1	10/03	1016.8
46035	57.0N	177.7W	740	7.6	8.1	1.1	2.7	19/02	11.2	SE	19.8	25/23	1014.1
46039	48.2N	123.4W	741	11.9					11.2	W	26.2	21/10	1019.4
46040	44.8N	124.3W	743	12.9	12.2	1.3	2.9	12/21	11.0	N	24.7	12/17	1020.2
46041	47.4N	124.5W	740	12.3	12.3	1.2	2.8	31/16	7.2	NW	19.4	26/22	1020.1
46042	36.8N	122.4W	716	13.1	13.2	1.6	3.1	01/10	8.5	NW	23.3	17/00	1014.9
51001	23.4N	162.3W	742	25.8	26.5	2.0	3.3	07/01	14.4	E	26.6	07/17	1018.2
51003	19.2N	160.8W	742	26.2	27.1	1.9	3.1	07/03	12.2	E	20.3	29/14	1015.2
51004	17.5N	152.6W	427	25.2	25.8	2.0	2.7	30/02	13.5	NE	19.2	29/20	1016.2
51005	20.4N	156.1W	369	24.4	25.0	1.7	2.8	06/17	18.9	E	29.1	12/16	1017.1
ALSN6	40.5N	073.8W	742	21.8	18.9				12.0	SW	32.0	17/06	1015.8
BURL1	28.9N	089.4W	739	27.9					9.3	SW	26.4	26/22	1017.4
BUZM3	41.4N	071.0W	735	20.0					12.3	SW	27.6	17/06	1016.5
CARO3	43.3N	124.4W	742	12.3					6.8	NE	29.0	12/20	1020.3
CHLV2	36.9N	075.7W	711	23.9	22.5	0.7	1.4	22/14	12.7	S	29.6	19/23	1018.2
CLKN7	34.6N	076.5W	739	26.0					10.3	SW	23.9	22/18	1018.6
CSBF1	29.7N	085.4W	737	27.2					5.6	S	17.5	26/13	1018.4
DBLN6	42.5N	079.4W	716	23.0					7.8	SW	27.0	11/05	1015.9
DESW1	47.7N	124.5W	739	12.7					10.7	NW	28.0	08/02	1020.2
DISW3	47.1N	090.7W	727	20.3					7.1	SW	59.4	15/12	1014.7
DPIA1	30.3N	088.1W	740	27.5	29.2				8.5	SW	25.2	05/22	1018.6
DSLN7	35.2N	075.3W	739	26.0	26.5				14.7	SW	34.4	22/04	1018.7
FBIS1	32.7N	079.9W	740	26.5					10.2	SW	23.0	22/17	1019.6
FFIA2	57.3N	133.6W	742	11.9					6.3	S	21.5	25/03	1015.4
FPSN7	33.5N	077.6W	741	26.3	26.7				13.2	S	35.1	13/23	1019.7
GDIL1	29.3N	090.0W	739	27.6	29.2				7.7	S	21.8	16/22	1017.2
GLLN6	43.9N	076.4W	685	21.4					7.5	SW	22.0	17/09	1015.4
IOSN3	43.0N	070.6W	740	19.5					10.6	S	31.0	17/05	1015.8

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
LKWF1	26.6N	080.0W	738	27.5	28.2				7.9	SE	25.0	07/01	1018.3
MDRM1	44.0N	068.1W	738	13.8					10.9	S	31.0	15/01	1014.9
MISM1	43.8N	068.9W	741	15.5					10.5	SW	28.0	14/21	1013.6
MLRF1	25.0N	080.4W	726	28.2	29.2				9.0	SE	23.6	09/07	1018.1
MPCL1	29.4N	088.6W	742	28.3	28.5	0.5	2.0	07/20	0.0	N			1017.9
NWPO3	44.6N	124.1W	740	12.2					9.4	N	28.0	12/17	1020.1
PILM4	48.2N	088.4W	719	14.6					8.7	S	31.0	13/22	1015.2
PTAC1	39.0N	123.7W	742	11.6					9.7	N	23.0	10/02	1015.6
PTAT2	27.8N	097.1W	738	27.9					11.4	SE	26.3	12/08	1015.9
PTGC1	34.6N	120.7W	742	14.1					11.6	N	28.6	13/08	1016.3
ROAM4	47.9N	089.3W	426	16.1	13.1				10.0	SW	34.9	29/08	1015.8
SAUF1	29.9N	081.3W	718	25.8	27.2				8.4	SW	24.2	06/06	1019.7
SBIO1	41.6N	082.8W	710	24.5					4.2	N	26.0	17/03	1015.8
SGNW3	43.8N	087.7W	719	21.0					8.2	S	26.9	31/23	1016.3
SISW1	48.3N	122.8W	742	12.9					9.2	W	29.0	12/18	1018.9
SMKF1	24.6N	081.1W	732	28.3	29.0				9.4	E	30.4	30/09	1018.3
SPGF1	26.7N	079.0W	702	27.8	29.4				5.5	SE	21.6	06/22	1018.7
SRST2	29.7N	094.1W	741	27.7					10.1	S	23.5	08/02	1017.0
STDM4	47.2N	087.2W	726	16.6					11.2	N	32.0	15/15	1015.9
SVLS1	32.0N	080.7W	732	26.5	27.6				12.8	S	26.8	23/17	1019.2
TPLM2	38.9N	076.4W	678	25.3	25.6				9.5	S	29.9	18/00	1016.8
TTIW1	48.4N	124.7W	742	12.6					7.4	S	29.0	19/14	1020.4
VENF1	27.1N	082.5W	740	26.5	29.6				6.5	E	20.7	06/19	1018.5
WPOW1	47.7N	122.4W	739	15.2					6.5	NE	21.1	13/02	1019.2
AUGUST		1988											
32302	18.0S	085.1W	742	17.3	18.4	2.5	4.8	13/21	13.3	SE	22.5	02/23	1018.7
41001	34.9N	072.9W	554	27.1	27.9	1.5	2.8	21/06	12.9	S	24.3	25/09	1016.7
41002	32.2N	075.3W	278	26.6	27.4	1.3	2.2	05/01	12.0	S	21.2	04/23	1019.7
41006	29.3N	077.4W	742	27.7	28.7	1.4	5.2	28/06	9.8	S	30.0	28/07	1017.2
41008	30.7N	081.1W	738	27.2	28.3	0.8	2.2	28/13	9.0	S	21.4	14/00	1016.1
41009	28.5N	080.2W	083	25.1	14.1	0.9	2.1	13/04	8.5	SE	22.3	12/21	3410.9
42001	25.9N	089.7W	740	28.7	30.0	0.6	1.5	09/09	0.0	N			1014.5
42002	26.0N	093.5W	741	28.8	30.1	0.5	1.1	01/03	6.7	SE	20.6	14/06	1013.9
42003	25.9N	085.9W	740	28.3	29.6	0.5	1.6	28/02	7.2	E	19.0	13/22	1015.2
42007	30.1N	088.9W	730	27.5	28.1	0.5	2.4	09/04	7.3	N	43.1	08/17	1014.8
42015	30.1N	088.2W	741	27.4	29.1	0.5	3.3	08/22	8.8	SE	33.4	08/21	1014.6
42016	30.2N	088.1W	738	27.4	29.0	0.4	1.7	08/19	9.2	SE	33.4	08/21	1014.3
44004	38.5N	070.6W	742	25.9	26.5	1.3	3.8	07/06	11.5	SW	27.4	07/07	1018.0
44005	42.7N	068.6W	742	19.4	18.1	1.0	2.7	25/03	9.3	SW	23.0	25/03	1016.5
44007	43.5N	070.1W	737	18.4	16.5	0.6	3.4	25/06	8.4	S	31.1	30/05	1014.5
44008	40.5N	069.5W	730	21.5	19.7	1.1	4.3	07/13	10.2	SW	28.8	07/12	1016.5
44009	38.5N	074.6W	740	22.6	21.5	0.8	1.7	24/13	10.7	SW	26.0	24/12	1016.2
44011	41.1N	066.6W	740	19.8	18.6	1.3	4.3	07/19	8.2	SW	20.1	07/16	1017.3
44013	42.4N	070.8W	741	21.0	18.0	0.4	2.4	24/22	0.0	N			1015.5
45001	47.6N	087.1W	739	15.2	14.0	0.5	2.9	06/05	9.6	W	25.0	06/04	1013.2
45002	45.3N	086.4W	739	20.4	20.6	0.6	2.2	23/13	11.2	SW	28.2	25/21	1013.3
45003	45.3N	082.8W	741	18.9	18.3	0.5	2.7	15/08	9.9	S	28.6	15/08	1013.8
45004	47.6N	086.5W	739	14.5	13.2	0.5	2.7	06/07	9.1	NW	24.1	14/23	1012.1
45005	41.7N	082.4W	737	24.0	25.1	0.4	1.5	15/07	9.1	SW	35.8	15/06	1015.1
45006	47.3N	089.9W	739	15.6	13.9	0.4	2.5	14/12	7.8	W	25.3	14/11	1012.5
45007	42.7N	087.1W	739	23.6	24.3	0.6	2.3	23/06	10.8	S	25.5	23/04	1014.1
45008	44.3N	082.4W	740	20.6	20.4	0.6	2.6	15/13	9.6	S	26.0	15/10	1013.7
46001	56.3N	148.3W	741	12.1	12.8	2.1	5.0	21/23	13.8	SW	29.7	21/20	1010.5
46003	51.9N	155.9W	739	11.1	10.2	2.1	4.0	18/22	15.0	SW	24.9	18/15	1013.2
46005	46.1N	131.0W	740	14.7	15.3	1.7	3.7	30/02	12.1	NW	20.2	02/14	1021.1
46006	40.8N	137.6W	606	17.4	18.2	1.4	3.2	29/21	10.7	N	21.8	28/08	1023.4
46011	34.9N	120.9W	739	15.6	16.1	1.4	2.8	16/02	8.9	NW	27.6	16/02	1013.6
46012	37.4N	122.7W	739	12.3	14.9	1.3	2.9	18/06	5.8	NW	15.5	20/18	1013.6
46013	38.2N	123.3W	741	13.0	12.8	1.6	2.9	18/06	10.9	NW	28.6	18/01	1013.2
46014	39.2N	124.0W	739	12.8	12.8	1.7	3.6	31/06	9.7	N	25.5	18/05	1012.8
46022	40.7N	124.5W	741	12.0	11.5	1.9	5.5	21/04	9.1	N	23.0	20/08	1014.9
46023	34.3N	120.7W	742	15.9	15.4	1.5	3.1	16/04	11.6	NW	27.4	16/02	1012.7
46025	33.7N	119.1W	739	18.5	20.4	0.8	1.6	15/05	5.9	W	17.8	06/04	1012.0
46026	37.8N	122.7W	740	13.8	14.8	1.1	2.0	18/03	9.2	W	25.3	18/06	1013.0
46027	41.8N	124.4W	712	11.7	11.0	1.8	4.7	21/03	9.6	N	36.9	01/23	1015.1
46028	35.8N	121.9W	742	15.5	16.1	1.5	2.6	16/04	9.6	NW	24.6	16/05	1013.3
46030	40.4N	124.5W	739	11.7	10.6	1.8	4.1	21/05	10.7	N	22.3	27/11	1013.9
46035	57.0N	177.7W	738	8.8	9.2	1.9	6.5	31/06	15.1	NW	34.6	24/01	1005.4
46039	48.2N	123.4W	740	12.4					8.2	W	24.1	05/05	1017.0
46040	44.8N	124.3W	740	12.2	11.2	1.5	3.4	30/19	9.9	N	21.6	20/05	1017.7
46041	47.4N	124.5W	740	12.5	12.4	1.3	3.5	01/12	5.1	NW	15.5	05/01	1017.5
46042	36.8N	122.4W	728	14.4	15.0	1.6	2.9	31/17	7.3	NW	23.3	25/02	1012.8
51001	23.4N	162.3W	740	26.1	26.9	1.7	2.7	04/09	12.5	E	19.0	22/20	1017.1
51003	19.2N	160.8W	737	26.6	27.5	1.8	3.0	06/03	11.4	E	20.7	08/08	1014.2
51004	17.5N	152.6W	740	25.6	26.1	2.0	4.2	05/03	13.6	NE	23.3	05/05	1014.7
ALSN6	40.5N	073.8W	741	22.6	20.5				12.1	SW	39.1	29/23	1015.8
BURL1	28.9N	089.4W	743	28.0					8.9	E	38.6	07/20	1013.9
BUZM3	41.4N	071.0W	740	21.1					13.4	SW	32.2	15/21	1015.9
CARO3	43.3N	124.4W	739	11.0					6.7	NE	23.0	21/00	1017.5

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
CHLV2	36.9N	075.7W	684	24.4	22.8	0.8	1.5	10/12	12.6	S	28.5	20/03	1017.5
CLKN7	34.6N	076.5W	741	26.8					10.4	SW	21.7	20/20	1016.6
CSBF1	29.7N	085.4W	741	27.4					6.0	S	19.0	03/21	1016.1
DBLN6	42.5N	079.4W	731	22.7					8.3	SW	27.0	15/10	1015.0
DESW1	47.7N	124.5W	739	12.8					7.6	NW	27.0	04/22	1017.7
DISW3	47.1N	090.7W	731	18.3					10.7	SW	31.8	07/23	1012.3
DPIA1	30.3N	088.1W	740	27.3	29.5				7.1	N	36.5	09/03	1015.5
DSLN7	35.2N	075.3W	742	26.9	27.7				15.5	S	31.1	05/15	1016.8
FBIS1	32.7N	079.9W	742	27.2					9.0	SW	30.0	28/15	1017.2
FFIA2	57.3N	133.6W	739	12.1					7.6	N	23.9	31/20	1010.3
FPSN7	33.5N	077.6W	741	27.0	27.9				12.7	SW	25.9	20/05	1017.4
GDIL1	29.3N	090.0W	736	27.4	29.6				7.4	SW	29.2	08/22	1013.7
GLLN6	43.9N	076.4W	691	22.3					10.8	SW	34.1	24/08	1015.0
IOSN3	43.0N	070.6W	743	20.7					10.6	SW	33.9	30/04	1015.8
LKWF1	26.6N	080.0W	733	27.8	28.7				7.4	SE	23.0	10/17	1015.8
MDRM1	44.0N	068.1W	739	15.1					11.8	SW	30.0	30/08	1014.7
MISM1	43.8N	068.9W	740	16.1					10.9	SW	33.1	30/06	1013.9
MLRF1	25.0N	080.4W	731	28.3	29.5				9.5	SE	25.3	15/02	1015.7
MPCL1	29.4N	088.6W	740	27.8	28.7	0.7	2.6	09/00	0.0	N			1014.5
NWPO3	44.6N	124.1W	738	11.3					7.6	N	25.0	20/00	1017.6
PILM4	48.2N	088.4W	668	16.0					11.2	S	31.8	23/05	1012.8
PTAC1	39.0N	123.7W	741	12.4					7.1	N	20.0	18/10	1013.3
PTAT2	27.8N	097.1W	742	28.0					10.0	SE	20.2	07/05	1013.5
PTGC1	34.6N	120.7W	738	15.1					12.1	N	29.2	15/11	1013.5
ROAM4	47.9N	089.3W	733	16.6	15.4				12.7	SW	34.6	06/00	1012.9
SAUF1	29.9N	081.3W	742	26.6	27.9				8.1	SE	22.4	16/00	1017.1
SBIO1	41.6N	082.8W	730	24.3					9.2	SW	33.1	14/20	1014.1
SGNW3	43.8N	087.7W	729	20.9					10.0	S	26.4	01/00	1013.9
SISW1	48.3N	122.8W	739	13.4					7.9	W	27.0	05/02	1016.5
SMKF1	24.6N	081.1W	731	28.5	29.0				10.5	E	29.8	13/02	1015.8
SPGF1	26.7N	079.0W	707	27.8	29.5				4.8	SE	20.3	12/14	1016.5
SRST2	29.7N	094.1W	740	28.4					8.3	SE	30.9	10/18	1014.2
STDM4	47.2N	087.2W	736	16.9					14.0	S	36.1	14/16	1013.1
SVLS1	32.0N	080.7W	743	27.3	29.2				11.8	S	40.6	28/14	1016.7
TPLM2	38.9N	076.4W	731	26.1	27.4				10.3	S	40.6	29/17	1016.8
TTIW1	48.4N	124.7W	742	13.0					7.7	S	34.1	24/20	1017.7
VENF1	27.1N	082.5W	743	26.4	30.4				5.2	E	26.7	27/18	1015.8
WPOW1	47.7N	122.4W	735	15.4					5.8	NE	15.3	16/01	1016.8
SEPTEMBER 1988													
41001	34.9N	072.9W	719	25.1	27.6	1.4	3.9	07/04	11.5	SW	31.8	07/02	1017.6
41006	29.3N	077.4W	717	27.6	28.1	1.3	2.9	06/20	9.5	E	22.1	06/16	1017.2
41008	30.7N	081.1W	717	26.4	27.7	1.0	2.9	08/03	11.0	E	28.4	06/15	1016.7
41009	28.5N	080.2W	434	91.8	90.2	1.0	2.2	13/02	9.3	E	25.8	06/00	3366.4
42001	25.9N	089.7W	719	28.0	29.0	1.5	6.6	16/15					1013.0
42002	26.0N	093.5W	718	27.4	28.6	1.6	9.7	16/08	12.4	SE	37.5	16/07	1012.8
42003	25.9N	085.9W	718	27.8	28.7	1.3	5.6	15/02	12.1	E	29.1	05/18	1014.2
42007	30.1N	088.8W	714	26.4	27.8	0.7	3.2	10/07	12.2	NE	38.7	10/01	1015.5
42015	30.1N	088.2W	185	25.4	28.1	0.9	2.0	04/19	14.2	NE	30.3	04/18	1011.9
44004	38.5N	070.6W	718	22.3	25.6	1.3	4.9	05/16	11.5	N	27.1	05/04	1018.8
44005	42.7N	068.6W	719	15.1	14.3	1.0	2.6	29/02	10.0	SW	24.9	05/04	1018.2
44007	43.5N	070.1W	718	14.7	13.8	0.6	3.0	05/06	10.1	S	25.3	05/02	1016.4
44008	40.5N	069.5W	703	17.4	17.5	1.0	3.2	05/18	9.8	S	28.6	05/04	1018.1
44009	38.5N	074.6W	714	19.3	19.5	0.8	2.4	29/11	10.5	N	25.3	29/08	1018.5
44011	41.1N	066.6W	718	15.5	15.3	1.2	3.7	05/20	7.6	NW	20.1	05/08	1018.4
44012	38.8N	074.6W	541	18.9	19.0	0.8	2.5	29/13	9.9	SW	25.6	29/06	1020.0
45001	47.6N	087.1W	719	12.3		0.9	2.8	04/17	11.2	W	23.7	20/18	1015.0
45002	45.3N	086.4W	715	16.0	16.8	1.0	3.8	08/19	14.3	SW	30.3	05/00	1015.2
45003	45.3N	082.8W	715	14.7	14.3	0.9	2.7	20/05	13.6	S	30.1	20/04	1016.1
45004	47.6N	086.5W	717	12.4	12.4	0.9	2.5	04/17	13.4	SE	27.2	04/21	1013.8
45005	41.7N	082.4W	714	18.7	20.3	0.5	2.0	29/02	10.9	S	27.4	20/06	1017.3
45006	47.3N	089.9W	716	13.5	12.7	0.6	2.2	09/16	9.7	SW	21.0	23/08	1014.0
45007	42.7N	087.1W	711	17.9	18.9	0.9	4.4	05/06	12.8	S	32.3	05/02	1015.7
45008	44.3N	082.4W	714	16.1	16.6	1.0	3.4	05/10	12.9	S	29.5	20/13	1016.1
46001	56.3N	148.3W	701	10.5	10.9	2.7	10.2	20/03	13.8	W	31.2	28/05	1009.2
46003	51.9N	155.9W	718	10.3	10.0	2.7	7.9	19/15	16.1	W	35.0	27/04	1011.7
46005	46.1N	131.0W	252	14.9	15.7	2.1	5.0	29/09	12.7	N	23.6	18/18	1020.9
46006	40.8N	137.6W	716	18.0	18.8	1.7	5.1	29/06	11.4	NE	26.4	24/17	1023.9
46010	46.2N	124.2W	096	13.0	12.0	2.0	3.8	29/23	10.4	N	22.3	27/04	1022.9
46011	34.9N	120.9W	717	14.2	14.7	1.5	2.8	18/00	9.1	NW	22.7	03/20	1014.3
46012	37.4N	122.7W	716	13.1	13.9	1.5	3.1	20/12	7.6	NW	24.4	20/05	1015.0
46013	38.2N	123.3W	719	12.0	12.0	1.7	3.5	21/04	10.8	NW	30.6	20/06	1014.6
46014	39.2N	124.0W	686	12.1	12.5	2.0	4.4	18/00	10.9	N	29.2	18/00	1013.9
46022	40.7N	124.5W	594	11.1	10.6	2.1	4.7	10/22	10.5	N	29.6	18/01	1015.4
46023	34.3N	120.7W	713	14.8	14.7	1.8	3.3	18/08	12.4	NW	25.3	03/05	1013.1
46025	33.7N	119.1W	717	17.8	19.2	0.8	1.4	12/20	5.6	W	14.4	14/00	1012.6
46026	37.8N	122.7W	329	12.5	14.0	1.2	1.8	01/02	8.1	W	21.8	03/02	1012.6
46027	41.8N	124.4W	651	11.0	9.8	1.8	3.6	10/05	11.1	N	35.0	11/02	1016.5
46028	35.8N	121.9W	717	14.5	15.5	1.7	3.0	18/13	10.8	NW	30.0	27/05	1014.1
46030	40.4N	124.5W	718	11.0	10.3	2.0	4.2	11/00	11.2	N	23.5	17/20	1015.4

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
46035	57.0N	177.7W	719	7.6	8.2	2.1	6.0	20/00	14.7	N	27.8	04/10	1009.2
46039	48.2N	123.4W	711	11.7									1018.2
46040	44.8N	124.3W	716	12.0	11.8	1.8	4.2	30/12	10.1	N	28.2	25/19	1018.9
46041	47.4N	124.5W	717	11.2	11.6	1.8	4.2	29/22	5.3	N	25.3	19/02	1018.3
46042	36.8N	122.4W	695	13.2	14.2	1.8	3.6	30/21	8.9	NW	23.3	03/02	1013.8
51001	23.4N	162.3W	718	26.5	27.3	1.7	3.1	05/14	10.8	E	20.3	27/16	1015.5
51002	17.2N	157.8W	211	25.7	26.9	1.9	3.1	22/20	13.7	E	21.2	22/05	1014.1
51003	19.2N	160.8W	718	26.8	27.5	1.9	4.4	04/21	11.8	E	27.6	04/21	1013.0
ALSN6	40.5N	073.8W	716	18.5	18.5				10.9	SW	31.0	04/19	1018.5
BURL1	28.9N	089.4W	717	27.3					12.8	E	55.8	09/23	1013.9
BUZM3	41.4N	071.0W	717	17.5					12.8	SW	32.0	05/03	1017.7
CARO3	43.3N	124.4W	718	11.1					8.0	NE	25.0	25/07	1018.8
CHLV2	36.9N	075.7W	678	21.0	21.2	0.9	2.0	30/00	12.3	NE	27.6	04/20	1019.5
CLKN7	34.6N	076.5W	717	23.9					10.3	NE	23.4	02/07	1018.0
CSBF1	29.7N	085.4W	718	26.3					6.5	NE	21.5	04/19	1016.1
DBLN6	42.5N	079.4W	717	17.2					9.3	SE	34.1	23/11	1017.5
DESW1	47.7N	124.5W	690	11.7					7.8	NW	39.1	19/01	1018.7
DISW3	47.1N	090.7W	717	14.5					11.8	SW	38.5	20/09	1013.7
DPIA1	30.3N	088.1W	694	25.4	27.0				6.9	N	31.1	09/22	1016.3
DSLN7	35.2N	075.3W	717	24.5	26.9				14.0	NE	35.7	05/04	1017.9
FBIS1	32.7N	079.9W	719	24.4					9.5	NE	32.0	05/04	1018.4
FFIA2	57.3N	133.6W	718	9.8					9.1	SE	35.5	11/13	1015.5
FPSN7	33.5N	077.6W	718	24.9	26.1				13.0	NE	33.7	07/19	1018.6
GDIL1	29.3N	090.0W	718	26.6	27.7				10.4	E	40.7	10/03	1014.0
GLLN6	43.9N	076.4W	712	16.7					13.0	S	32.0	20/23	1017.3
IOSN3	43.0N	070.6W	716	15.7					11.7	W	31.8	05/03	1018.0
LKWF1	26.6N	080.0W	711	27.9	28.2				10.2	E	23.0	08/14	1015.7
MDRM1	44.0N	068.1W	710	12.6					13.5	SW	34.1	05/06	1016.1
MISM1	43.8N	068.9W	715	13.3					13.2	SW	33.1	05/05	1016.4
MLRF1	25.0N	080.4W	716	28.2	29.0				12.3	SE	37.6	13/18	1015.3
MPCL1	29.4N	088.6W	710	27.2	28.1								1014.8
NWPO3	44.6N	124.1W	718	11.5					7.6	N	27.0	08/23	1018.9
PILM4	48.2N	088.4W	505	13.0					13.9	W	32.4	23/13	
PTAC1	39.0N	123.7W	718	11.3					8.5	N	24.0	08/19	1014.7
PTAT2	27.8N	097.1W	715	27.0					13.0	SE	29.9	17/15	1013.4
PTGC1	34.6N	120.7W	717	13.9					13.2	N	31.3	03/12	1014.0
ROAM4	47.9N	089.3W	651	13.2	12.4				15.6	W	35.0	04/15	1013.5
SAUF1	29.9N	081.3W	718	26.4	28.2				10.1	E	26.4	07/23	1017.4
SBIO1	41.6N	082.8W	717	18.7					10.8	SW	39.1	23/06	1017.6
SGNW3	43.8N	087.7W	716	15.3					11.6	S	29.7	19/20	1015.7
SISW1	48.3N	122.8W	717	12.3					6.8	W	31.0	19/04	1017.8
SMKF1	24.6N	081.1W	704	28.3	28.8				13.8	E	34.5	14/00	1015.4
SPGF1	26.7N	079.0W	708	28.1	29.1				7.2	SE	21.4	13/02	1016.3
SRST2	29.7N	094.1W	717	26.0					8.8	NE	25.2	30/08	1014.7
STDM4	47.2N	087.2W	715	13.3					16.9	S	38.1	04/15	1014.8
SVLS1	32.0N	080.7W	710	25.4	27.0				13.7	NE	33.7	07/20	1017.6
TPLM2	38.9N	076.4W	719	20.5	22.8				9.8	S	26.0	04/12	1019.7
TTIW1	48.4N	124.7W	717	11.7					9.3	S	31.0	02/11	1018.5
VENF1	27.1N	082.5W	716	26.8	29.0				7.7	E	25.4	05/17	1015.5
WPOW1	47.7N	122.4W	711	13.9					7.0	NE	30.3	23/13	1018.1

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